Concrete

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Winter Concreting Methods

Applied On

Contract of Moderate Size

Wall-Bearing Construction Prolonged Concreting Period—Necessary to Avoid Expensive Mixing Plant—Place Dependence on Men in Charge of Concrete Work—Frequent Tests Made—Winter Concrete Plant Equipment—Coal and Coke Consumption of Boiler and Salamanders—Cost of Winter Concreting

By **ROBERT C. JOHNSON**
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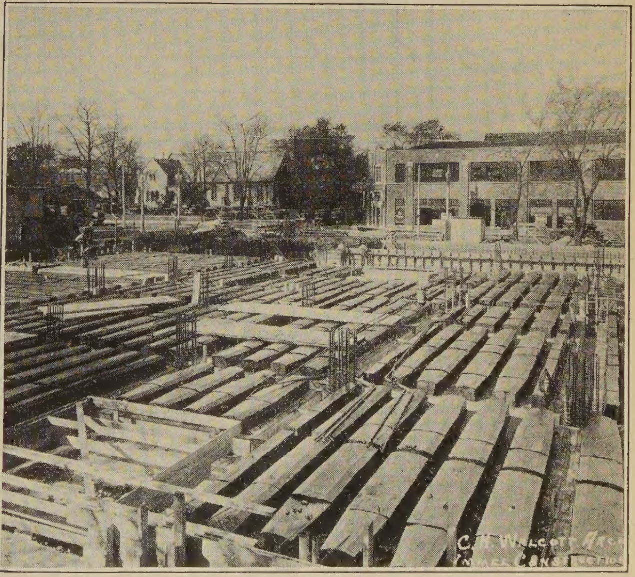
The story of winter concreting told in this article is an ideal illustration of an instance where methods and equipment were adapted to the size of the contract. The excellent results obtained, at the moderate cost of $1.04 per cu. yd. of concrete, prove again that no concrete construction work need be delayed on account of the winter season. Even this cost may be more than offset by the advantages arising from the other sources enumerated by the author.—The Editors.

THE construction of the Y. M. C. A. building in Kenosha, Wisconsin, erected during the past year, illustrates some of the typical concrete problems met by a general construction organization.

This building is four stories and basement, 120 feet by 150 feet, and contains a swimming pool, gymnasiums, assembly rooms, and dormitory rooms. The entire exterior is faced with Indiana limestone. The structural framing is divided into two sections, one of which is entirely wall bearing, and the other structural steel skeleton encased in concrete. The structural floors are all of reinforced concrete, partly metal dome and partly solid slab construction. The general contract amounted to approximately $600,000.

Work was started in July, 1929, and the exterior was completed in May, 1930. There are approximately 4,000 cu. yds. of concrete in the building distributed through the footings, walls, and floors. This concrete was specified as 1:2:4, and four samples were to be tested from every run. Due to the fact that the building was partly wall bearing construction, the placing of the concrete was of necessity stretched over a period of approximately nine months. With the small yardage involved, and the long concreting period, it was apparent that any installation of concrete plant more than a mere concrete mixer would run up the plant cost per yard to an excessive figure. In other words, the rental charges for anything more than



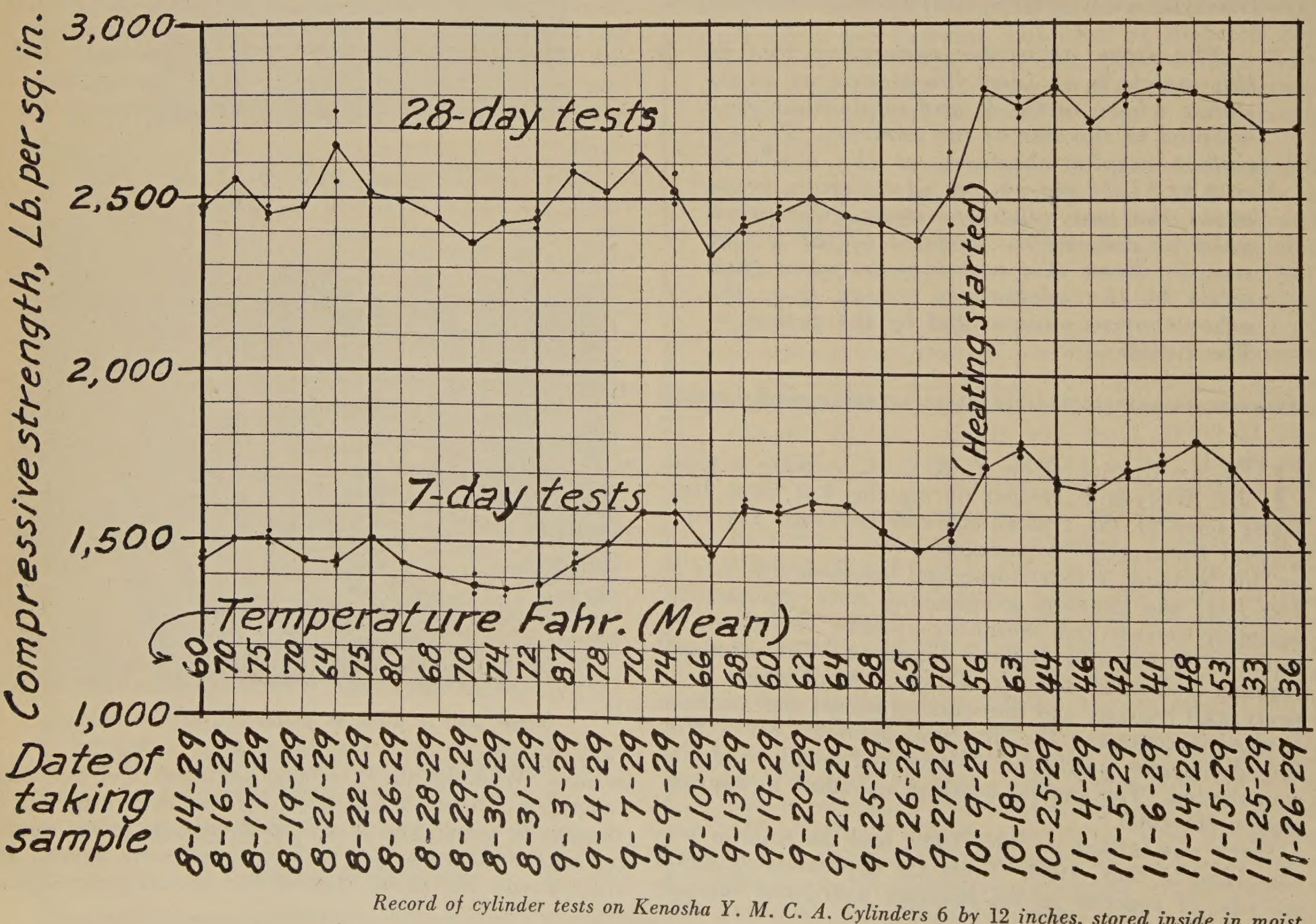
Metal forms in place, in preparation for concreting the absolutely essential concrete mixer would far exceed in cost per cubic yard any possible benefit to be derived from the installation.

Experienced Men in Lieu of Scientific Equipment

The total value of all of the plain and reinforced concrete work, including the forms but excluding the reinforcing material, was only $55,000. The total estimated cement was worth only $11,000. The most efficient plant installation could not possibly save more than 10 per cent of the value of the cement, or $1,100. This amount distributed over the period of nine months would pay for very little batching equipment or other control devices. With this thought in mind the general superintendent was selected for his knowledge and experience in placing reinforced concrete. His past experience was such that he would not require all of the modern plant controls which are now used for concrete mixes. He in turn carefully selected his concrete foreman. This man was an intelligent and ambitious mechanic who had had several years' experience operating concrete mixers.

Newly concreted floor, covered with canvas and kept warm by heat of salamanders below

With this personnel available, it was definitely decided



Record of cylinder tests on Kenosha Y. M. C. A. Cylinders 6 by 12 inches, stored inside in moist to eliminate all mechanical controls and to place full responsibility for the quality of concrete directly on the general superintendent and the mixer foreman, trusting to their excellent previous records as an assurance of quality. The method of measuring aggregates was by wheelbarrow. No control was placed on the water either entering the mixer from the tank or upon the water contained in the aggregate. No time batcher or time control was placed on the mixer. The matter of the quality of the concrete was left directly to the experience of the men handling it.

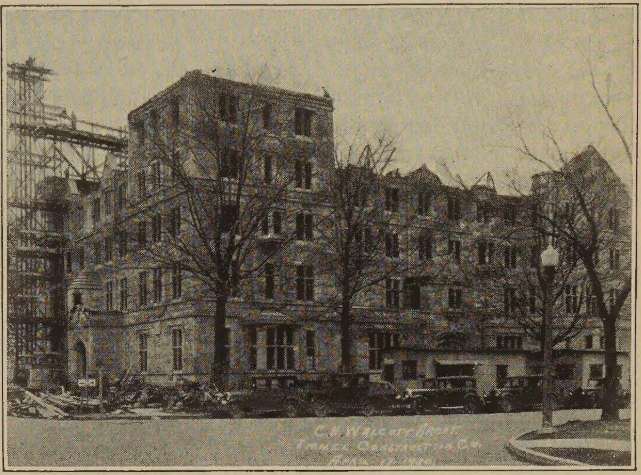
Frequent Tests as Check on Quality of Concrete

As a safeguard under this method of mixing, more samples were taken for testing than were specified. An average of eight to ten samples were taken each day, with at least two of them being broken at the end of seven days. The man in charge of the concrete mixer never knew when these samples were being taken, as they were taken directly from the forms as the concrete was being placed.

Preparations for Winter Concreting

In view of the fact that the placing of concrete on this job would extend through the winter of 1929 and 1930, numerous temperature and storage conditions were outlined for the job. One man was detailed through the winter months to take three test cylinders from each sample of concrete, one sample to be broken at seven days and cured on the forms, one sample to be broken at 28 days and cured on the forms, and one sample to be broken at 28 days and cured in damp sand at 70 deg. F. The same man was required to keep the following temperature records:

1. Outside temperatures at 7 a. m., at 12 noon, and at 5 p. m.
2. Temperature of concrete as it entered the forms.
3. Temperature under the canvas cover at the top of freshly placed concrete.
4. Temperature at the point on the forms where the outside samples were stored.
5. Temperatures at the bottom of freshly concreted slabs.

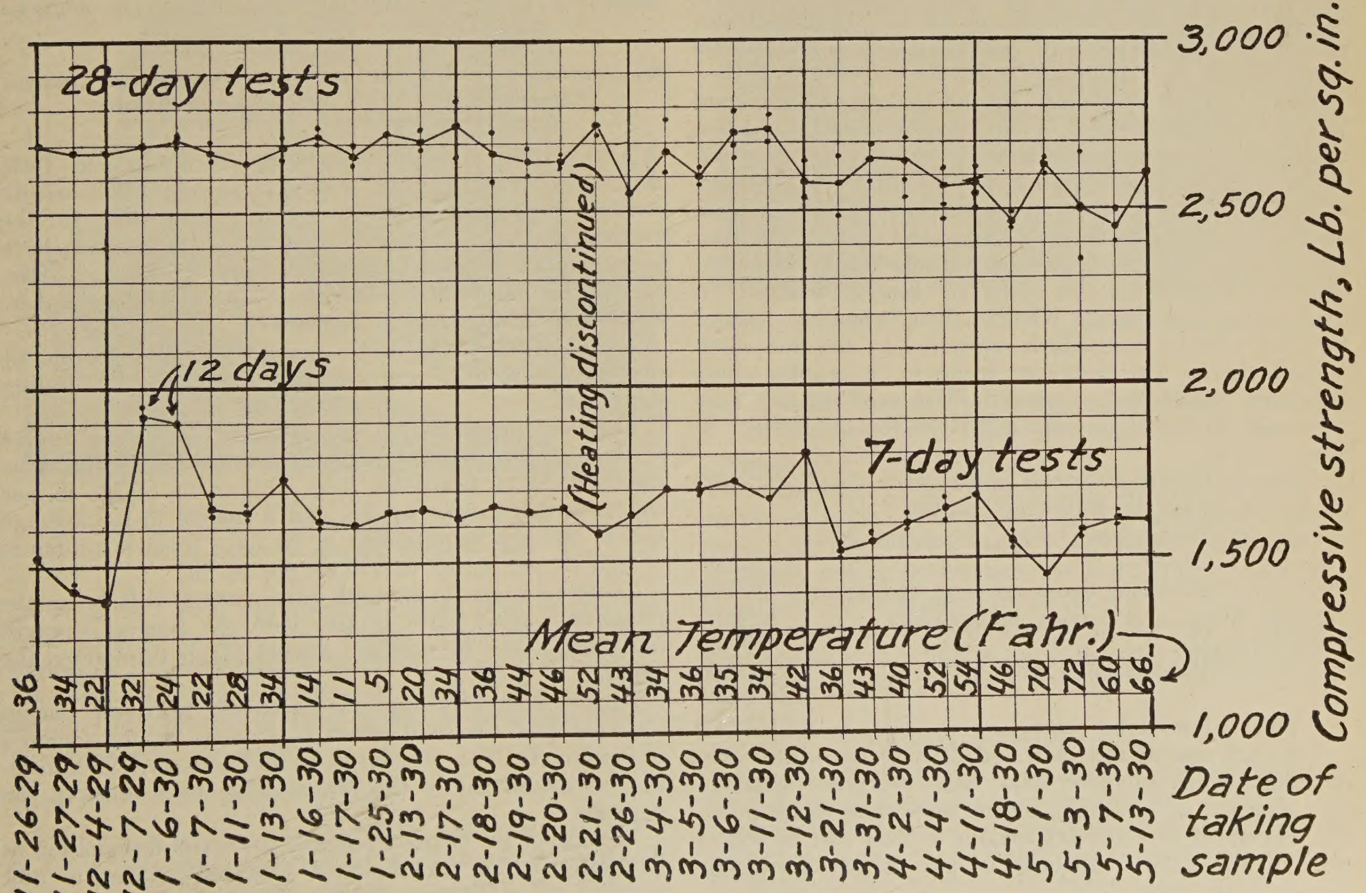


Kenosha Y. M. C. A., a bearing wall building with reinforced concrete floors, approaching completion. C. H. Walcott is the architect

All of these temperature and sample records were kept in a daily diary at the job office.

Winter Concreting Equipment

The specifications covering the job for the placing of winter concrete consisted of only two clauses. The first clause specified that the temperature of the concrete enter-



sand. Construction work heated from October 9th, 1929, *to February* 21*st*, 1930, *inclusive* ing the forms should be between 60 and 80 degrees, and the second clause required that the temperature of the freshly placed concrete should be kept at a minimum of 70 degrees for at least five days after concreting. The exact details as to how these specifications were to be lived up to were left to the general superintendent.

The following winter concreting plant equipment was required for this protection: One second-hand vertical steam boiler with a capacity of 100 lbs. pressure; 150 lin. ft. of steam hose, with perforated iron pipe points; approximately 100 salamanders; canvas, 10,000 sq. ft.; Sisalkraft, 20,000 sq. ft.

As soon as the form work for a floor was completed the window openings in the story immediately below it were closed with canvas, thereby closing that story against the outside weather. The salamanders were meanwhile distributed on the floor just below the one to be concreted, with one salamander to about 180 sq. ft. of floor area, and were fired before the actual placing of concrete was started. As fast as the concrete was placed it was covered with Sisalkraft. The heat from the salamanders below and the protection of this covering were sufficient to maintain proper temperatures for the curing of the concrete.

Coke Consumption of Salamanders

As a matter of job record, tests were run to find the coke consumption of the salamanders. The results were as follows:

Salamander		Coke Consumed
Height in.	Diameter in.	in 72 Hrs., Bu.
15	16	8
30	18	6
18	18	10

The consumption results of these salamanders would indicate that a very interesting study of heat results in salamander consumption in relation to size could be developed from thorough-going tests.

Two test runs were made on the boiler. It was found that it consumed 70 lbs. of coal per hour and furnished steam at an average pressure of 70 lbs. for steaming out forms. The coal consumption was found to be the same when the boiler was merely used for furnishing live steam under low pressure for the heating and thawing of sand and gravel. There is undoubtedly room for the development of an efficient steam boiler for heating materials in cold weather concreting. Whether there is enough demand for such a boiler can only be answered by the equipment manufacturers. This, however, seems to be an item which they have overlooked, as most boilers used for this purpose are purchased second-hand from regular dealers in steam boilers.

Accurate record of winter work labor costs was kept on the job, with the following results:

Setting up, firing, and taking down the steam boiler	$ 632.00
Putting up and taking down canvases and paper	244.00
Tending, firing, and moving salamanders	1068.00
Snow removal	491.00
Small miscellaneous labor costs	97.00
Total winter labor cost	$2532.00

The total cost of material used directly for winter construction, which included coal, coke, worn-out salamanders, canvases and building paper, snow shovels, ice picks, etc., amounted to $1620.00, making a total cost of winter work of $4152.00, or about $1.04 per cu. yd. of concrete placed on the entire job.

Considering the total cost of this construction and the amount of invested capital, this item is so small that it should never receive serious consideration and should never be permitted to hold up an ordinary construction contract. There is no question that the increased efficiency of labor and the continuous use of the contractor's equipment and personnel more than make up for the direct costs of winter construction.

Test Data Prove Results Best in Winter

The results of the concrete tests on this job are shown in the accompanying curves. It is very interesting to note that, as stated above, although there was no mechanical control of the proportions in this job the maximum variation from high to low in 28-day strength was only 450 lbs., or less than 20 per cent. These results are far more uniform than have previously been obtained by the same personnel when using weighing batchers, water measuring tanks, and time batchers under the supervision of testing engineers. Another striking result of these curves is that from the period of October 9th to February 21st, which was the period during which temporary heat was being furnished both to the aggregate and to the freshly placed concrete, the strength of the material was far more uniform than during the previous and later periods when the concrete was subjected to considerably greater variations in temperature. These results show conclusively that when proper attention is paid to the heating of materials and the curing of the concrete, the conditions are more ideal for obtaining uniform results than during the periods when the aggregates and curing periods are subject to the temperature changes of normal atmospheric conditions. No construction organization with proper experience or personnel should be afraid to undertake the manufacture of field concrete during cold weather.

New Strength Requirements for Portland Cement Accepted

Membership of A. S. T. M. Casts Favorable Vote on Changes —High-Early-Strength Requirements Given— Testing Apparatus Standardized

REVISIONS in the Standard Specifications and Tests for portland cement, involving an increase in tensile strength requirements and the fixing of tolerances for the various pieces of apparatus used in testing cement, have been adopted by the American Society for Testing Materials following a favorable vote by the society's membership in a canvass held in September.

Eleven items in all were included in the revision, of which nine were concerned with tolerances for testing apparatus.

Revisions in the strength requirements include a change in the average tensile strength at seven days for the three standard mortar briquettes from a minimum of 225 lb. per sq. in. to 275 lb. per sq. in., and a change in the average tensile strength requirement at 28 days from a minimum of 325 lb. per sq. in. to 350 lb. per sq. in.

These revisions in strength requirements will bring the minimum values more in line with the general strength level maintained by portland cement plants throughout the country.

Specifications for high-early-strength portland cement were accepted for publication as tentative by the society's Committee E-10 on Standards, at its February, 1930, meeting, as mentioned in the March issue of CONCRETE, on page 26.

Because of the changes adopted the serial designation of the specification for standard portland cement is now changed from C9-26 to C9-30. The serial designation of the specification for high-early-strength cement is C74-30T.

Concrete Units Replace Damaged Brick-Work in Bridge Pylons

High Absorption of Brick in Wall Back-Up Caused Expansion — Walls Gradually Forced Outward — Cast Stone Facing Removed and Reset with Back-Up of Hollow Concrete Units Which Were Approved on Basis of Test Report

THE brickwork comprising the back-up for the cast stone facing in three of the four large pylons at the Twenty-third Street viaduct over the Illinois Central railway tracks, in Chicago, has been torn out and replaced by a back-up of hollow concrete masonry units. The work was started on September 8th and required about 15 days for its completion.

The pylons, which are square in plan, were built eight years ago for the South Park Commission of Chicago. The construction as originally built consisted of four thick walls faced with Benedict cast stone and backed with common clay brick, forming a hollow square.

Expansion of Brickwork Forces Walls Outward

Because of the high absorption and consequent expansion of the brick backing, the walls of three of the pylons were gradually forced outward, until their dangerous condition made it necessary to brace them. Two braces, in the form of yokes, were placed around each of the damaged pylons, as shown in Figure 1. This illustration shows the southeast pylon before its removal and repair. The opening up of the vertical joints in the cast stone masonry may clearly be seen, as well as the outward bulge in the walls of the pylon.

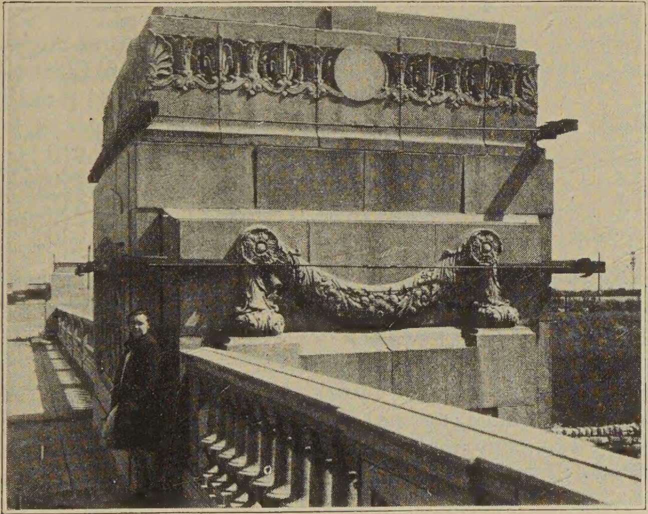


Figure 1. Opening of vertical joints in cast stone facing was caused by expansion of brick backing. Note bracing yokes necessitated by outward bulge of walls

How Brickwork Disintegrated

Figure 2, a view of the northwest pylon in the process of being torn down, shows the brick back-up originally built. Due to the absorption and expansion, the cohesion of the brickwork had become largely destroyed, and the individual bricks could easily be removed. Some of the mortar, which appeared to be a lean mixture of lime and sand, had disintegrated. Furthermore, the uneven movement between courses of brickwork had caused shearing of the horizontal joints in some instances.

Rebuilding the Pylons

The first step in the reconstruction of a pylon was the careful removal of the cast stone top and facing. This material was lifted off with a derrick, set on the sidewalk and carefully cleaned. In the meantime the brickwork was torn down and the base of the pylon was cleaned in preparation for reconstruction.

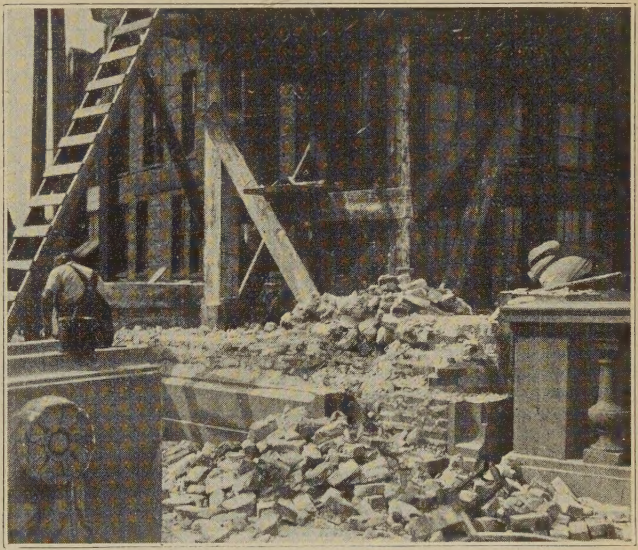


Figure 2. Northwest pylon when removal of brick backing was nearly completed.

Figure 3 shows the start of the reconstruction of the northwest pylon. The 8 by 8 by 16-inch hollow concrete back-up units are being set in 1:3 portland cement mortar, tempered with hydrated lime, and the cast stones are being returned to their original positions.

The reconstructed southwest pylon is shown in Figure 4, this picture having been taken before the joints in the cast stone were pointed up.

Bricks Were Highly Absorptive

No original construction records are available regarding the percentage of water absorbed by the common clay brick used as back-up. It is not likely that absorption tests were made at the time. However, a sample brick picked up 24 hours after its removal, during which time no rainfall occurred, was dried in a gas oven to constant weight, then immersed in water for 48 hours, when it was found to have absorbed water to the amount of 18.14 per cent of its dry weight.

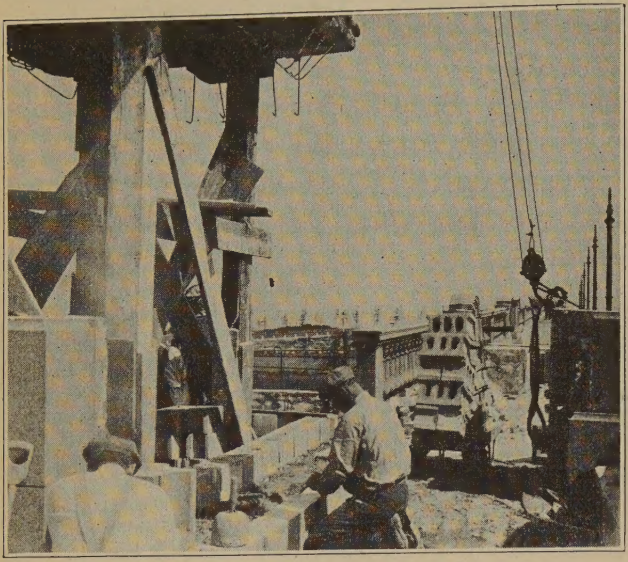


Figure 3. Reconstruction of northwest pylon started, with hollow concrete units for backing

The complete test data on the sample brick selected is as follows:

Dimensions, 8¼ by 3¾ by 2⅜ in.
Weight when selected, 4.62 lb.
Dry weight, 3.97 lb.
Weight after 48 hrs. immersion, 4.69 lb.
Gain in weight, 0.72 lb.
Absorption, 18.14 per cent of dry weight.

From the foregoing data it will also be seen that the brick, when taken from the structure and after being exposed to sun and air for 24 hours, contained moisture to the amount of 16.37 per cent of its dry weight, although the summer of 1930 was a season of subnormal rainfall.

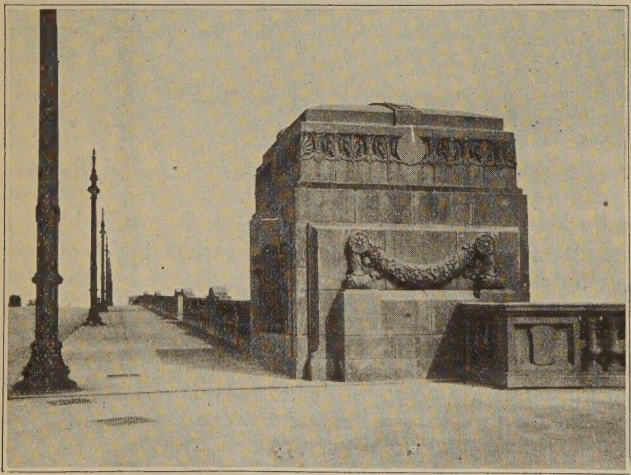


Figure 4. Southwest pylon reconstructed, but before joints in cast stone were pointed up

Concrete Units Approved on Basis of Tests

The hollow concrete masonry units employed as back-up in the reconstructed pylons were approved by the engineering department of the South Park Commission on the basis of a test report submitted by Van Houten Brothers Concrete Products Co., of Chicago, manufacturers of the concrete units.

The tests covered by the report were made at the Materials Testing Laboratory of Lewis Institute, Chicago, by Prof. J. Gardner Bennett. The tests indicated an average absorption of 8.43 per cent and an average compressive strength of 1,280 lb. per sq. in. over the gross area and 2,040 lb. per sq. in. on the net area of the concrete. Prof. Bennett's report follows:

Result of Tests—These blocks easily satisfy all requirements.

Required compressive strength, 700 lb. per sq. in.
Van Houten Bros. blocks, 1,280 lb. per sq. in.
Maximum allowable absorption 15 per cent by weight.
Van Houten Bros. blocks, 8.43 per cent, by weight.
Desired strength of concrete, 2,000 lb. per sq. in.
Van Houten Bros. blocks, 2,040 lb. per sq. in.

Tests—Standard compression and absorption tests of American Society for Testing Materials. For the compression test, blocks were bedded in 1:1 cement gypsum mortar and loads were applied through a spherical bearing block on a Universal testing machine. In the absorption test, blocks were dried in a gas oven to constant weight. They were then immersed in water for 48 hours and the weight taken. The gain in weight divided by the dry weight times 100 gives the per cent absorption.

ABSORPTION TESTS

Block No.	Weight, Dried, in lb.	Weight, Damp, in lb.	Per Cent Absorption, by weight
1	48.51	52.49	8.25
2	47.25	51.25	8.45
3	49.50	53.75	8.58
Average of three			8.43 per cent

COMPRESSION TESTS

Block	Ultimate Crushing Load, in lb.	Ultimate Unit Stress Wall (Gross) Area in lb. per sq. in.	Unit Stress on Concrete (Net) Area in lb. per sq. in.
1	157,400	1,250	2,010
2	163,720	1,320	2,090
3	158,820	1,280	2,030
Average of three		1,280	2,040

Blocks were 8 by 8 by 16 in., 40 days old, made with an aggregate containing 11.10 per cent limestone screenings.

E. L. Archibald & Company, Inc., of Chicago, had the general contract for the reconstruction of these pylons. As previously stated, the cast stone was made by the Benedict Stone Company and the hollow concrete units by Van Houten Brothers Concrete Products Co., both of Chicago.

Civil Engineers Convene

The fall meeting of the American Society of Civil Engineers is being held at St. Louis, Mo., at the Hotel Jefferson October 1st to 3rd.

The first paper scheduled for presentation at the construction division, meeting on the morning of October 2nd, is one by Jas. S. Taylor, chief, division of building and housing of the Department of Commerce. L. R. Viterbo, consulting engineer, will tell about "Floating Foundations," and O. E. Mogensen, secretary, F. L. Smidth and Company, and S. W. Bowen, second vice-president, Fruin-Colnon Contracting Company, will deal with the subject of "Caisson Foundations."

The highway division program will be held beginning at the same hour.

Delivering
60,000 Cubic Yards of Centrally Mixed Concrete in Month

Warner Company's Philadelphia Plants Designed for Large Production—Company Supplies "Certified Concrete" — Agitator Type of Truck Selected — Technical Control by Independent Inspection Company—Co-operate with City Inspection Bureau

By R. P. BROWN

A VISIT to the centrally-mixed concrete plants of the Warner Company in Philadelphia is the equivalent of a week's time divided between the most modern concrete laboratories and the most progressive construction jobs in the field. The reason is that no detail in the fabrication of the best possible concrete has been overlooked, and it is a true joy for an engineer, architect, or contractor to watch the smooth flow of materials from the stock-piles on through to the delivery trucks. At no point is chance allowed an opportunity to reduce the high standard set by this progressive company for its product. Every pound of material is weighed, proportions are scientifically determined and maintained equally rigidly. Only the best materials are used; absolutely clean sand and gravel, high-grade portland cement and pure water, and where admixtures are used a correspondingly high standard is maintained.

Some years ago the Warner executives, as leading producers and dealers in building materials in the East, saw the increasing need of contractors and architects for a dependable supply of high-grade concrete delivered on the job so as to insure maximum strength, conserve job storage space and permit increased efficiency in design. With this idea in view the Warner Company undertook an elaborate series of tests involving thousands of concrete specimens of all proportions, of sand, of gravel, of cements, and of methods of mixing and delivery.

Why Centrally Mixed Concrete Is Favored

As a result of this preliminary work the centrally mixed concrete put out by this company was promptly and well received by the building fraternity of Philadelphia—architects, contractors and engineers alike. Many instances arise where space and time are at a premium on the job and the contractor is more than glad to be relieved of the responsibilities of stocking raw materials and mixing his concrete on the job. In other cases the architects and engineers specify proportions designed for certain desired strengths which are difficult to handle in the field. Here a central mixing plant is particularly valuable, and the company is equipped to furnish any mix of concrete on short notice. In fact, the plants are so organized that the necessary adjustments for making a special batch may be made in less than a minute after the order reaches the mixing floor. In still other cases, those in charge specify the use of Warner Central-Mix Concrete (known as CMC), knowing from past experience that it will be of uniformly high quality and that deliveries will be dependable. These factors permit of added supervision of the other problems involved in concrete construction.

The Warner Idea

In Bulletin 1, issued by the Warner Company in April, 1930, Charles Warner, president of the organization, says: "Concrete that is pre-mixed under proper methods and then properly transported to the point of its use should be more uniformly homogeneous and be a denser product than that which is produced by ordinary job-mixing practice where the supervision, control and treatment of the ingredients is less skillful.

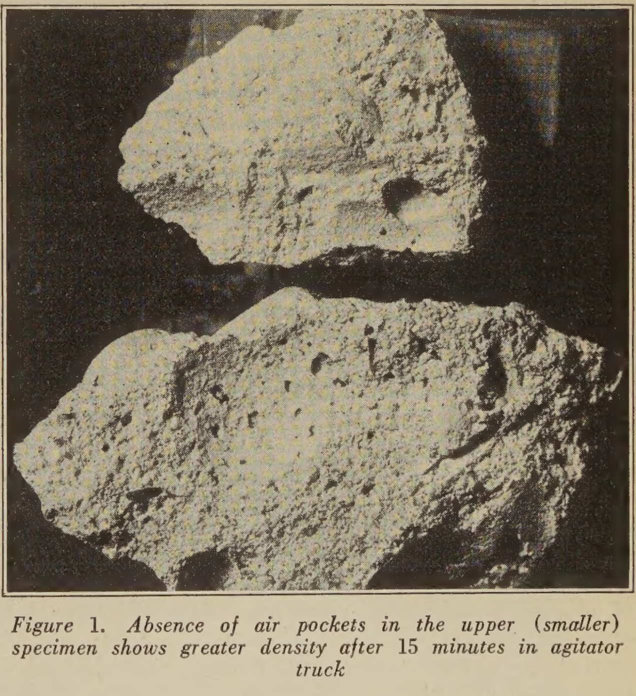


Figure 1. *Absence of air pockets in the upper (smaller) specimen shows greater density after* 15 *minutes in agitator truck*

"The supervision in a pre-mixing plant must cover the selection of the cement, sand, and gravel; the water-cement ratio; the proportioning of the mixtures; the method of blending and the important feature of transportation in safe time and proper condition to the job.

"After several years of study, and with the best obtainable engineering advice, the Warner Company has adopted

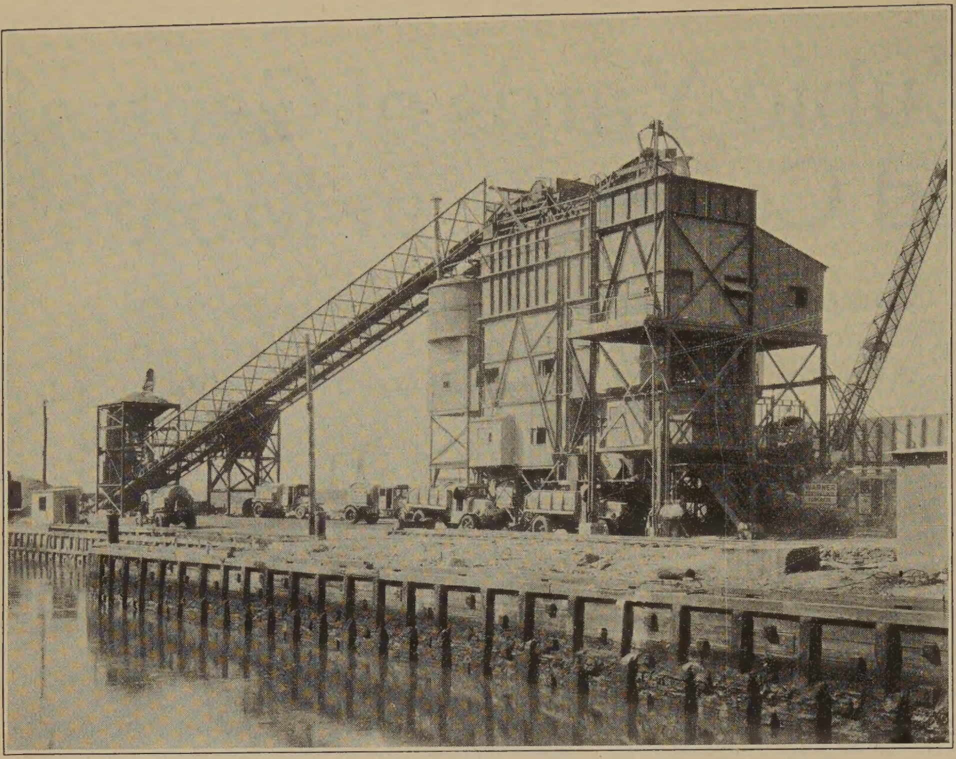


Figure 2. Berks Street plant, from which 30,000 cu. yds. of centrally mixed concrete were delivered in August

the principle of Central-Mix Concrete.

"In practice, this principle permits: first, exact proportioning of the water, cement, and aggregates according to specification, with trained supervision at the central plant, and, second, the transporting of this pre-mixed product in a revolving drum agitator which is not a mixer.

"Many practical tests and all our experience in manufacturing and transporting indicate that mild agitation en route to placement is the best method of densifying and strengthening concrete. There is no doubt that such agitation removes air voids due to mixing, while also avoiding segregation of the ingredients.

"Realizing our responsibility to architects, engineers and contractors for this new concrete product, we have employed an independent laboratory organization to maintain independent inspection and testing control over its production. This constant supervision will also enable us to take advantage of any later improvement in concrete practice which may develop as a result of further engineering research."

One of the first problems to be decided was that of how the mixed concrete was to be taken to the job. As a result of their investigations, the Warner Company decided that all structural concrete should be delivered in agitator type trucks. This decision was due to a careful technical study of all factors involved in the fabrication of high quality concrete, and the question of entrained air was carefully considered. They started their fleet with 15 Clinton trucks, and now have 85. Each truck is equipped with a tank having a capacity of 4 cubic yards.

Tests showed that there is ordinarily from 12 to 15 per cent of entrained air in concrete as it comes from the mixer. The effect of this air is shown in Figure 1.

The Clinton equipment for reducing this air consists of a cylindrical tank horizontally mounted on a truck chassis by trunnion bearings at both ends. Filling and discharge doors are provided, and an elevating mechanism for dumping. The interior of the tank is smooth and without blades or paddles, and the cylinder is constantly kept slowly revolving, so long as it carries any concrete, by means of a separate motor, which insures quiet but constant agitation regardless of traffic stops. As the tank is not entirely filled, the practice being to load only 3½ cubic yards to a batch, the slow rotary motion causes a kneading action and insures a gradual turning over of the contents, permitting the entrained air to escape. Consequently, as the usual hauls range from 30 minutes to 1 hour, the amount of entrained air is reduced to the minimum.

Tests made by the E. L. Conwell Co., of Philadelphia, for the Clinton Motors Corporation, of concrete being delivered on Warner jobs show that this removal of entrained air has a favorable effect upon the strength of the concrete. This is shown by the following typical test reports:

Sample Taken at	Proportions	Gallons of water per sack	Slump, Inches	Compressive Strength, lbs. per sq. in.	Haul in Min.
Mixer	1:2.09:3.81	7.65	6.0	2415 2310 2280 2335 Av.	----
Job	1:2.09:3.81	7.65	5.5	2615 2530 2520 2555 Av.	20
Mixer	1:2.09:3.81	8.40	6.5	2125 2070 2210 2135 Av.	----
Job	1:2.09:3.81	8.40	6.0	2325 2410 2280 2305 Av.	45

Inspection Company Controls Making of Concrete

Not satisfied with knowing that their concrete was the best they could produce, the Warner Company has taken a still greater step forward, and now furnishes what is known as "certified concrete." Further, this certification is not a mere statement of their own engineers, but is furnished by an independent testing and inspection company to whom the Warner Company has given absolute control of the mix, checking the amounts of cement, sand and gravel as they are weighed into the batch, and setting the water tank so that only a known and verified amount of water can be added during the mixing process. An inspector is stationed at each mixer and verifies each batch, and he in turn must receive the okay of the chief inspector before any change can be made in the mix. This system is working out remarkably well and it is to the credit of all parties concerned that no friction has arisen between the inspectors and the mixing crews. In place of friction there is an evident desire on the part of the plant men to co-operate with the inspectors.

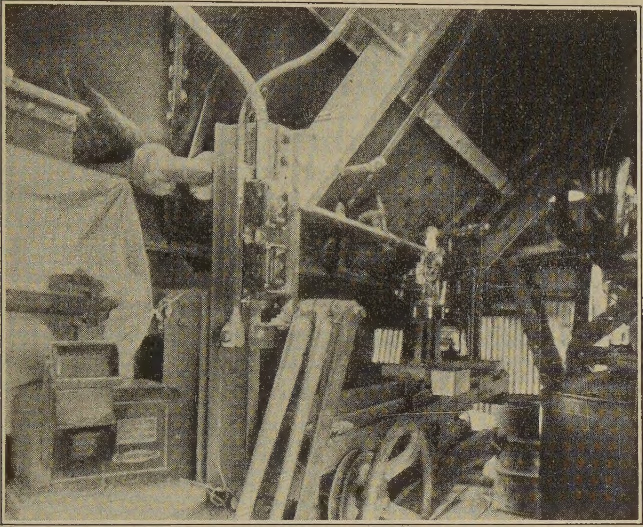


Figure 3. Weighing and measuring controls installed for each of concrete mixers

Not only is the mix certified as to content, but the inspection force checks the sand and gravel at each mixer four times a day to determine the moisture content and also the gradation of the aggregates. Any variation in moisture content is corrected by changing the volume of mixing water being added to the batch so as to compensate for the difference, and variations in the grading of the aggregates are also remedied. To avoid gaps in grading, it is a simple matter to make a correction from an adjoining bin, which keeps the gradation within the specification limits set by various bureaus, architects and engineers in the Greater Philadelphia district.

Running Check Tests on Construction Job

At the start of every job where "certified concrete" is furnished, the inspection staff makes a set of not less than 6 standard 6 by 12-inch or 8 by 16-inch cylinders on the job, and breaks them at 7 and 28 days. These tests are made at the laboratory of the E. L. Conwell Co. in Philadelphia. Typical results are here shown:

Proportions	Gallons Water per Sack of Cement	Slump in inches	Age in days	Compressive Strength in lbs. per sq. inch
1:2:4	7.50	7	7	1555
				1420
This mix carries 1.16 quarts of Anti-Hydro per sack of cement				1505
Average				1493
1:2:4	7.38	6	28	2470
				2470
This mix carries 1 quart of Anti-Hydro per sack of cement				2355
Average				2431

These results are reported to the Warner Company and to such departments or bureaus as have jurisdiction over the job.

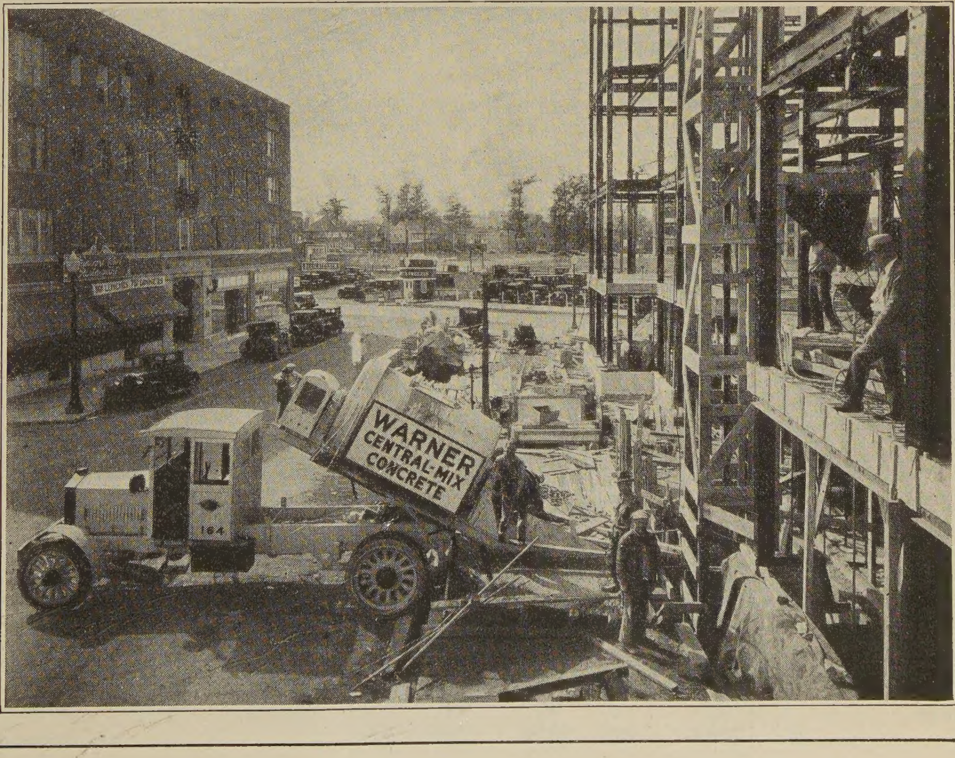


Figure 4. Delivering centrally mixed concrete with a Clinton truck equipped with an agitator body

The building code of Philadelphia requires that every structural concrete job shall be under the supervision of a competent concrete inspector who shall watch the material at all times and make and break cylinders at intervals, reporting the results to the Bureau of Building Inspection. This inspector is in the employ of the owner.

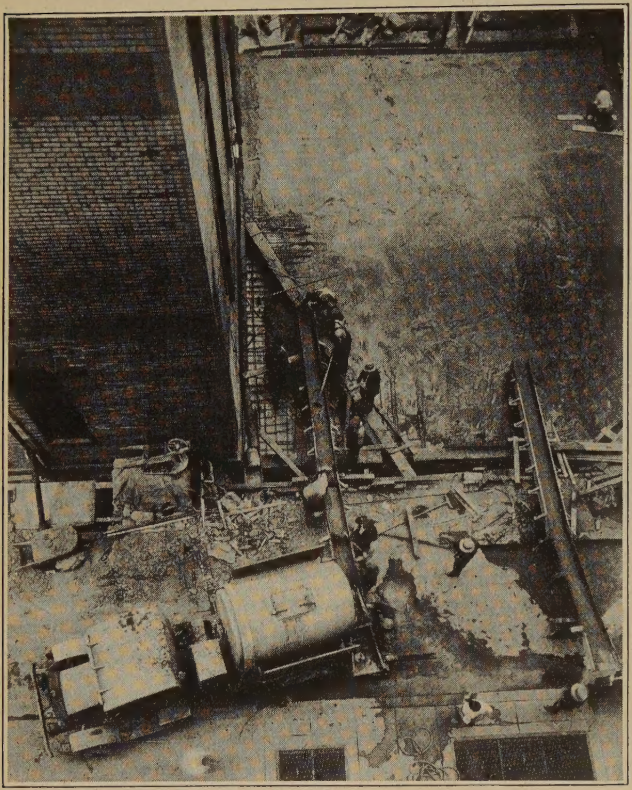


Figure 5. View from above, showing concrete being delivered directly into a distributing chute

The Warner Company has delivered more than 700,000 cubic yards of structural concrete on hundreds of jobs, and reports that there has not been a single instance where the independent tests have failed to verify the tests which form a part of the company certification. There have been perhaps half a dozen cases where discrepancies apparently existed, but upon study by impartial authorities the company's certification has been upheld in each case. This record is one of which the company is naturally proud, and the company executives are doing everything in their power to maintain it.

TRANSVERSE STRENGTH

Length of Haul Minutes	Age in Days 3	7	28
60	221	285	531

All results based on 9 cylinders each.

Transverse tests were made on beam specimens 6 by 6 by 40 in.

TENSILE STRENGTH

Tests made on 8 by 11 by 72 in. beams with 3 smooth, round ¾-in. bars, but no stirrups.

Length of Haul	Age in Days 7		28	
Minutes	v	f_c	v	f_c
60	170	1635	234	2445

Each figure based on 6 specimens.

COMPRESSIVE STRENGTH

Tests made on 8 by 11 by 72-in. beams containing 12 stirrups (¼-in.) set on 3-in. centers in addition to tension bars as used in the tension tests.

Length of Haul	3 days		7 days		28 days	
Minutes	v	f_c	v	f_c	v	f_c
60	217	2043	248	2370	306	2958

Meeting the City's Inspection Requirements

Philadelphia's requirements are strict, and early in the history of this new development Morris Brooks, chief of the Bureau of Building Inspection, requested that an impartial study of the structural characteristics of the concrete be furnished. These tests, cited below, were made by Professor H. C. Berry at the University of Pennsylvania under his personal supervision and that of three representatives of the Bureau. The tests were made during the period from December 5, 1929 to January 28, 1930. Concrete was taken at random from trucks going to different jobs, six separate loads being sampled. The remarkably close agreement between the compressive strength shown by the cylinders and that shown in the reinforced beam tests is notable.

In the tests made for the Bureau of Building Inspection, the water-cement ratio was 0.96 (7.2 gallons of water per sack of cement), giving a 5½-in. slump. The mix was a nominal 1:2:4, with actual proportions of 1:2.09:2.83 on a dry, rodded basis. Specimens were made at the Christian Street plant of the Warner Company from material taken from trucks, and the aggregates used were the standard washed products of the Tullytown Delaware River dredging plants of the Warner Company.

COMPRESSIVE STRENGTH

Length of Haul Minutes	Age in Days 3	7	28
30	936	1468	2308
60	978	1560	2432

Three-day results are based on 9 cylinders each; 7 and 28-day results are on 15 cylinders each.

BOND STRENGTH

Length of Haul Minutes	Age in Days 3	7	28
60	264	496	794

Three-day results based on 6 cylinders; 7 and 28-day results on 12 specimens each.

Bond tests were made by casting a ¾-in. round bar 6 in. deep in a standard 6 by 12-in. cylinder and then pulling it out under tension.

The Berks Street Plant

At the mixing plants the principle of technical control is combined with efficiency in the handling and mixing of the materials. A good idea of the general layout of the main plant may be had from Figure 2. At this plant, known as the Berks Street plant, the sand and gravel are unloaded from the Warner Company's barges to a stockpile over a tunnel feeding a 36-inch rubber belt conveyor which takes the materials to the storage bins over the mixers, which in turn feed the batch measuring hoppers. Coarse aggregate (1½ and ¾-in. gravel) is unloaded with a 2½-cu. yd. clamshell bucket to a stockpile maintained at about 500 tons for the 1½-in. gravel and 300 tons for the ¾-in. material. Sand is handled from the barges by

(Continued on page 29)

Colored Architectural Concrete in Large Country Residence

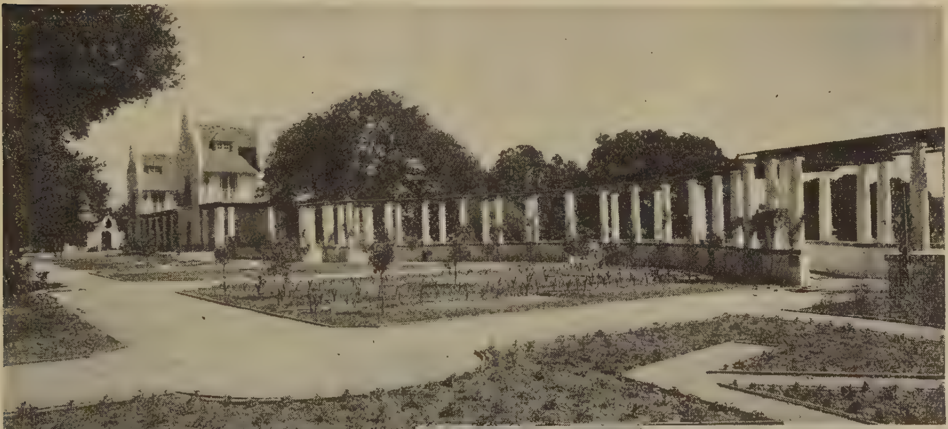
San Francisco Architect Asserts Color Now a Part of Architectural Treatment of Concrete—Combines Well with Landscape—Formal Garden Described

By JOHN K. BRANNER
Architect, San Francisco, Calif.

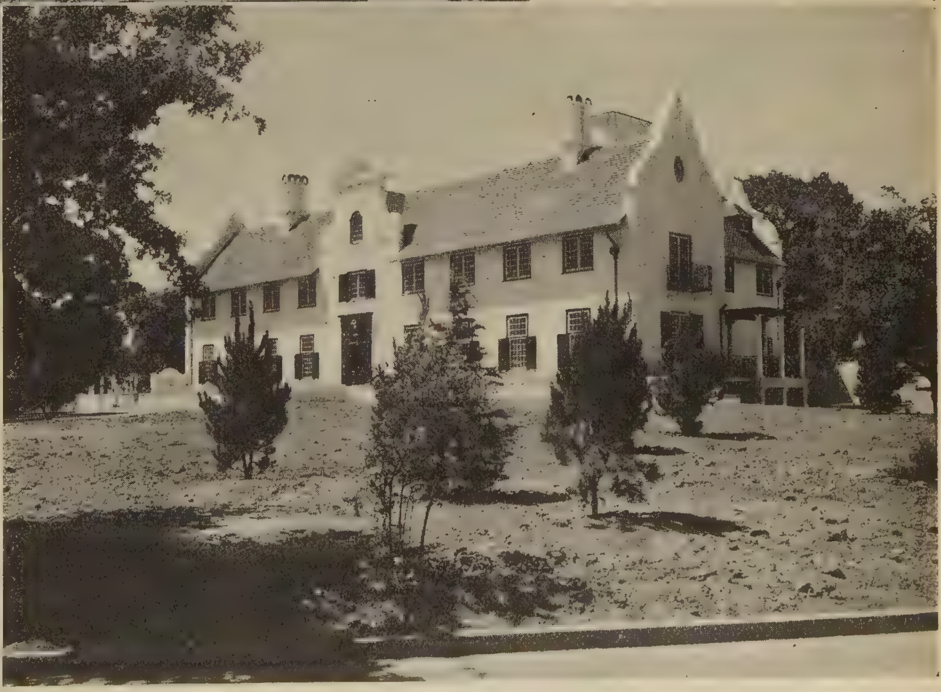
THE new country residence for William Wallace Mein, president of the Calaveras Cement Company, recently completed near Woodside, about 25 miles south of San Francisco, should be of interest to architects who believe in the architectural possibilities of concrete. The first major point of interest is the type of architecture selected —a type quite in contrast with the Spanish residential architecture frequently employed in connection with concrete and stucco. The second point to be emphasized is the use of colored concrete in the exterior of the building proper, and in the enclosed court and the formal garden.

Dutch Colonial Architecture

This residence is designed in the Dutch Colonial type of South Africa, where the owner lived for many years. The house is on a hill, and between the two wings there is a court, or atrium, facing a formal walled garden in which are many orange trees.



The formal garden development, looking toward the house. Fluted pillars support the long pergola



A view of the country residence of William Wallace Mein, president of the Calaveras Cement Company. Its architecture and its employment of colored concrete are of prime interest

The house is firesafe, with reinforced concrete gable walls which rise above the roof. The gables are ornamented with scrolls of Dutch character. The floors are of structural concrete, laid on light fabricated steel joists, and surfaced with oak and teakwood nailed to furring strips in the concrete. The roof is covered with dark grayish brown shingle tiles.

Color a Part of Architecture

Color has definitely become a part of architectural concrete. Much of the beauty of the design detail of this residence is due to the use of colored concrete, as in the case of the floor of the enclosed court. This is laid out in checkerboard design in black and white. The balcony above this court is supported by fourteen white concrete columns.

In the formal garden development concrete has been used exclusively, and with pleasing results. There are concrete seats, and fluted pillars support the long pergola leading away from the house. Opposite the columnar inner court, across the formal garden, is a highbacked concrete seat, with scrolls to match those in the gables of the house. There is a concrete plunge pool in the middle of the formal garden.

From the pool can be seen the enclosure which makes up the formal garden, with its curved and straight boundary walls of concrete with several seats built in the walls. The scroll work in these seats is colored in yellow ochre to relieve, and enhance the beauty, of the long stretches of white wall.

Combines Well With Landscape

The landscape has many oak trees similar to the Flemish oaks which grow in South Africa, which combine with the general design to make the whole arrangement truly Dutch Colonial in character. The structures make the entire plan at once beautiful and permanent.

The plans were prepared by the writer, in association with Sir Herbert Baker, a well-known architect of London, England, who formerly lived in South Africa. The general contractors were Chas. Stockholm and Sons of San Francisco.

Detroit Manufacturer Uses Three Different Mixes for High-Grade Floor Tile

The Ventimiglia Tile Company, Detroit, of which Carl Ventimiglia is manager, has been in business three and one-half years. It specializes in the manufacture and installation of a high grade colored concrete floor tile.

Mr. Ventimiglia carried on extensive experiments before finally adopting his present method of manufacture, having, in the meantime, tried fifteen different methods, none of which produced results that were completely satisfactory.

He now uses three different mixes and mineral oxides for coloring. The tile are made under a pressure of 60 tons, and are cured both by steam and water. Special methods of manufacture are followed, and four men will usually produce a total of a thousand tile a day.

Mr. Ventimiglia makes his own patterns in any design and color, and furnishes any special work of reasonable character. The standard units are 8 by 8 by ⅞ in., 6 by 6 by ⅝ in. and 4 by 4 by ⅜ in. A base tile is also furnished, 6 by 8 in. by any required thickness.

The Ventimiglia Tile Company now has to its credit a number of excellent examples in and around Detroit. There are outdoor installations that have been in for two years, and an apartment entrance and walk that have been in for the same length of time, with no indication of wear.

The unit has been used in residences, restaurants, stores, apartments, churches, banks and schools. The excellent appearance of the tile may be seen in the Bungalow Cafe in Dearborn, Mich., here illustrated.

An installation of Ventimiglia floor tile in the Bungalow Cafe, Dearborn, Mich.

Where Pavement Money Goes

More than half of the money spent on hard surfaced road building goes directly to workmen, according to Fred R. White, chief engineer of the Iowa Highway Commission.

Considering the average paving job a force of from 40 to 60 men is needed, depending on the locality, for each paving outfit. In addition, considerable labor is needed for grading and bridge building. For laying a mile of pavement these men, together with the men who make the cement, handle the aggregate, make the reinforcing steel, etc., receive 52 per cent of the cost of the pavement.

Coming Conventions

Sept. 29-Oct. 4—Pacific Coast Building Officials' Conference, ninth annual meeting. Virginia Hotel, Long Beach, Calif.

October 1-3—American Society of Civil Engineers, fall meeting. Hotel Jefferson, St. Louis, Mo.

October 6-11—Sixth International Road Congress. Constitution Hall, Washington. D. C.

October 20-22—Concrete Reinforcing Steel Institute, semi-annual meeting. Briarcliff Lodge, Westchester County, New York.

January 10-16—American Road Builders Association, convention and road show, St. Louis, Mo.

January 19-22—National Crushed Stone Association, fourteenth annual convention. New Hotel Jefferson, St. Louis, Mo.

~ EDITORIAL ~

Keeping Young With Your Business

A RECENT issue of "Printers' Ink" quotes the following rare bit of business philosophy from a sales memorandum of Guy S. Osborn, Inc.:

> The only thing that stays young from year to year is Business.
>
> New methods in handling and doing business are constantly being introduced. New and modern machines are regularly replacing the old. It is essential, therefore, to study and keep abreast of the progress of the times. Never get older than your business.
>
> Keep young with your business. Don't get behind it—keep up with it.

This philosophy applies with special force to the concrete construction and concrete products manufacturing industries, in which new developments are continually under way.

From the time a structural design is first visualized in the mind of the architect or the engineer, to the day when the last rubbish is cleared away from the completed structure, the man who keeps young with his business will economize where another will waste.

The well-informed structural designer will know of new developments in materials and methods that will produce a lighter superstructure of greater strength, which means a structure of lower cost than the uninformed designer will produce.

The specification writer who understands the details of making better concrete through the application of the most modern knowledge on the subject will open the way for the use of that knowledge.

The contractor who keeps up with progress in construction methods will install a modern concrete mixing plant on all important projects, and he will handle his materials and distribute his concrete by means of labor-saving methods or equipment, at unit costs below those of his less progressive competitor.

In the realm of concrete products manufacture, the man who keeps up with his business is continually studying his market with the view of building up demands for new products.

The men who keep young with their business are the men who keep themselves informed of developments, through their trade associations, their technical societies, and the trade and technical press.

A More Permanent Kind of Fire Prevention

THE forthcoming fire prevention week offers an opportunity to inaugurate a more far-reaching kind of fire prevention effort than is possible in a week's round of programs and speech making.

In this advanced year of 1930 school buildings, hospitals and kindred structures are still being built of a type of construction sometimes called "semi-fireproof," an expression that is proved wholly meaningless whenever a disastrous school or hospital fire occurs.

Usually the construction of buildings such as schools and hospitals is in the hands of a small group of men who have made a success in some line of business not related to construction. When the time comes to build, there is the usual inadequacy of funds. Perhaps it were more to the point to say that there is the usual desire to build bigger than the available funds will permit.

In either case the result is the same. "Economy" is played up as the reason for discarding plans for a modern reinforced concrete building and switching to a type that offers no safety against disaster.

The men who are responsible for such decisions are not influenced by events such as fire prevention week—at least not permanently, and least of all when they think a few thousand dollars can be "saved." They can be convinced of their folly only through the personal efforts of men who know construction and whose judgment carries weight.

The concrete construction fraternity of every community have a duty to perform, as well as an advantage to gain, in bringing an understanding of true fire prevention to the small groups of locally influential men who make the final decisions on types of construction. Such a "campaign" is not spectacular, but it gets results.

Eliminating Highway Grade Crossings

ELIMINATION of grade crossings on main highways is occupying increasing attention of highway engineers.

It has long been realized that grade crossings between highways and railways are direct invitations to fatal accidents, and that grade crossings between highways cause both accidents and traffic jams.

The necessity of first building a primary road system has compelled highway officials of most states to hold grade separation in the background. In states where the primary systems have been completed this phase of highway construction is well under way. This is true especially in states having large centers of population. For illustration, the Pennsylvania state highway department has eliminated 26 highway-railway grade crossings in the last year.

The main consideration involved in grade separation between highways lies in the planning and building of structures that are attractive in appearance, and that accomplish their purpose without being too complicated or occupying too much space.

Current Activities of Organized Groups

Many knotty problems pertaining to cement and concrete are either in course of solution or recently completed by organized societies or smaller groups. The busy reader may keep himself informed by watching these items.

Changes in A. S. T. M. Standards

ALL REVISIONS and changes in status of standards authorized at the recent annual meeting of the American Society for Testing Materials have been given the final stamp of approval by the membership of the A. S. T. M., according to the letter ballot canvassed on September 2nd, 1930.

The authorized increase in the mortar tensile strength requirements in the Standard Specifications and Tests for Portland Cement, mentioned on page 20 of the August issue and in several previous issues, establishes the new 7-day requirement at 275 lbs. per sq. in., and the 28-day requirement at 350 lbs. per sq. in., compared with the former figures of 225 and 325 lbs., respectively. The new serial designation of this standard will be C-9-30.

The changes authorized in the Standard Specifications for Billet-Steel Concrete Reinforcement Bars were described on page 26 of the August issue. The serial designation of this standard is accordingly changed from A 15-14 to A 15-30.

Among the former tentative standards that have been advanced to the status of full standards, three are of interest to the concrete construction industry. These are the Methods of Test for Field Determination of Approximate Apparent Specific Gravity of Fine Aggregate, the serial designation of which is now changed from C 68-28 T to C 68-30; the Methods of Test for Field Determination of Approximate Percentage of Voids in Fine Aggregate, the serial designation being changed from C 69-28 T to C 69-30; and the Methods of Test for Field Determination of Surface Moisture in Fine Aggregate, the serial designation of which is changed from C 70-28 to C 70-30.

Another former tentative standard which is now advanced to the status of full standard is of interest to manufacturers of portland cement. This is the Methods of Test for Fineness of Powdered Coal, which now has its serial designation changed from D 197-26 T to D 197-30.

Revising Government Specifications for Waterproofing, for Concrete Tile and for Masonry Cement

THE FEDERAL Specifications Board of the United States Bureau of Standards is now revising three of its existing standard purchase specifications covering commercial commodities bought by the various departments and independent establishments of the federal government.

Integral Waterproofing. One of the standard specifications now undergoing revision is Federal Specification No. 444a, for integral waterproofing material of the water-repellent type, for use with portland cement mortar or concrete.

Plain Concrete Pipe. Another of the standard specifications now being revised is Federal Specification No. 495, for Plain Concrete Pipe.

Masonry Cement. The third standard now in the process of revision is Federal Specification No. 443, for Masonry Cement.

Copies of each of the specifications listed above have been submitted to representative manufacturers and other interested persons for comment and criticism. Suggestions for changes must be in the hands of the Board not later than October 24th.

Government Master Specifications for Concrete Masonry Building Units

FEDERAL MASTER specifications for hollow concrete masonry units, both load-bearing and non-load-bearing, have been approved by a sub-committee of the Federal Specifications Board of the United States Bureau of Standards, and copies have been sent out to the trade for comment and criticism.

The specifications prepared and approved by the sub-committee are the result of tests on 50 different products collected from 18 different states.

In the essential requirements the proposed master specifications are in agreement with the American Concrete Institute's Standard Specifications for Concrete Building Block and Concrete Building Tile. The master specifications, as finally adopted, will become the purchase specifications for the various construction departments of the United States government.

A. S. T. M. Tentative Specifications for Concrete Masonry Units

PREPARATION OF the proposed Tentative Specifications and Tests for Load-Bearing Concrete Masonry Units has been completed by a sub-committee of Committee C-10 of the American Society for Testing Materials.

As stated on this page in the May issue, the sub-committee held its first meeting on April 3rd. The tentative standard proposed by the sub-committee has now been mailed out to the members of Committee C-10 on Hollow Masonry Building Units for a vote by letter ballot.

So far as the essential features are concerned, the proposed tentative standard does not differ from the recommendations in the American Concrete Institute's Standard Specifications for Concrete Building Block and Concrete Building Tile.

Engineering Inspection Association Organized

THE NATIONAL Engineering Inspection Association has been organized for the purpose of co-ordinating and improving the practice of those engaged in engineering inspection. Membership may include individuals, partnerships or corporations regularly engaged in engineering inspection work.

The secretary-treasurer of this new organization is B. H. Witherspoon, president of the Pittsburgh Testing Laboratory, Stevenson and Locust Sts., Pittsburgh, Pa.

Circular Concrete Arch Dam Designed by Simple Method

Formulas Apply to Dam with Constant Cross-Section in Any One Horizontal Plane—Taking Account of Shrinkage and Expansion from Temperature Changes and Other Causes

I—Design Formulas and Diagrams

By R. P. V. MARQUARDSEN
Asst. Engineer, Chicago Terminal Improvement,
Illinois Central R. R. Co., Chicago, Ill.

The author presents here a remarkably simple method for obtaining the stresses in a concrete dam of the circular arch type and having a constant cross-section in any one horizontal plane. The working formulas and diagrams actually required by the designer are given in this installment, and their use is explained. The next installment will contain the derivations of the formulas.—The Editors.

FOR a number of years the writer has been "playing," off and on, with the elastic theory as applied to arches fixed at both ends, in the hope of devising a method of arch analysis that would be easy to apply and, at the same time, be fairly accurate.

During this time it has developed that certain special arches lend themselves to an easy analysis. Chief among these is the concrete circular arch dam of constant cross-section in any one horizontal plane. Some of the reasons that this type of arch is easier to analyze than other types are that—

(1) The radial loading is uniform (for the same depth of the dam).

(2) The dead load (i. e., the weight of the dam) may be disregarded as far as arch action is concerned.

(3) The arch is symmetrical.

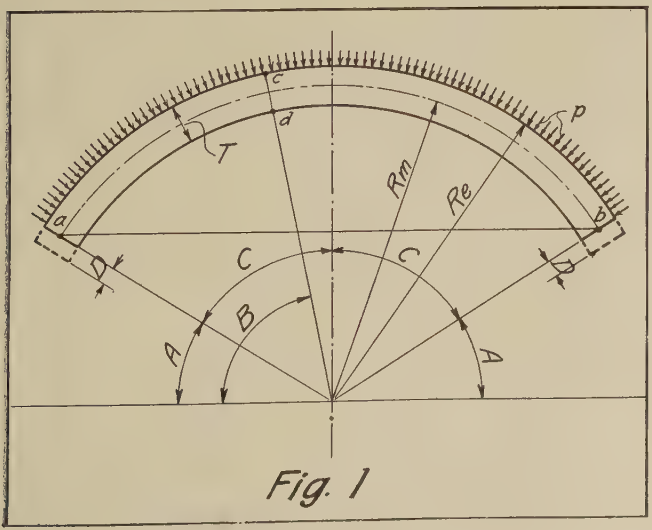


Fig. 1

This article sets forth the method devised by the writer for investigating the stresses in this type of arch. The method is based on the supposition that concrete will take tension as well as compression. If, after the effects of all the forces acting have been combined, it should be found that tension actually exists in certain parts of the arch, such parts can be reinforced in the usual manner; or, which perhaps would be more logical, in such manner that the neutral axis will remain in the place where it would be if the concrete could take tension.

Method Outlined

In order to give the reader at once an idea of the simplicity of the method, the formulas to be used for finding the unit stresses at any section of the arch will be stated dogmatically at the outset and their derivation indicated later.

Figure 1 represents the "elevation" (sectional plan view) of a circular arch dam of constant cross-section, the following data being given:

A = Angle that the end sections make with the "horizontal" (i. e., with the line a-b).

B = Angle that the section under consideration makes with the "horizontal."

C = Angle that each of the two end sections makes with the "crown" section (i. e., one-half the central angle of the arch).

D = Depression or settlement (assumed equal at both ends) of the arch supports, along the end tangents.

E = Modulus of elasticity of concrete.

Re = External radius, or the radius of the upstream side of the arch, at the depth under consideration.

Rm = Mean radius, or the radius of the center line of the arch, at the depth under consideration.

T = Thickness of the arch, at the depth under consideration.

c = Coefficient of linear expansion or contraction. Usually taken equal to 0.0000055.

p = Unit water pressure on the arch, at the depth under consideration.

t = Rise or fall (in degrees Fahrenheit) in the temperature of the arch from its temperature at the time it was built.

If it is desired to find the stresses at any section other than the "crown" section and the end sections, as, for instance, at section c-d, Figure 2, it will be desirable to draw, to any convenient scale, an "elevation" of the arch and to locate a line *e-f*, parallel to line *a-b*, at a distance from the arch center line at the crown equal to $Kx \cdot Rm$,

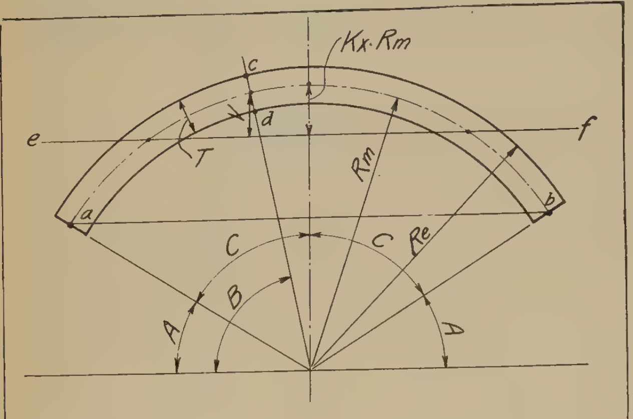


Fig 2

where the value of Kx is a function of angle C and may be taken directly from Figure 3.

The line *e-f* having been established, the unit stress f at the extreme fiber of any section, as *c-d*, may be found by applying the following formula:

$$f = \frac{P - H \sin B}{T} \pm \frac{6 V H}{T^2} \quad \text{(1)}$$

The plus sign is to be used for finding the unit stress on the extrados side of all sections whose center falls above line *e-f*, and the unit stress on the intrados side of all sections whose center falls below that line; and the minus sign is to be used for finding the unit stress on the intrados side of all sections whose center falls above line *e-f*, and the unit stress on the extrados side of all sections whose center falls below that line. If the value of f is negative, the unit stress will be tensile; if positive, it will be compressive.

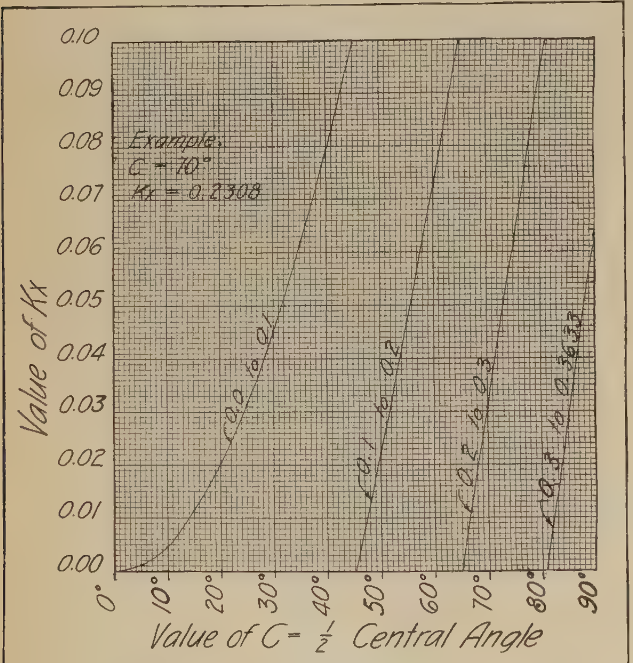


FIG. 3

In this formula—

V = the perpendicular distance between line *e-f* and the center of the section under consideration, as scaled from the "elevation" of the arch already drawn.

$$P = p\,Re \quad \text{(2)}$$

$$H = \frac{(P \pm c\,t\,E\,T)\sin C + (D\,E\,T \div Rm)\cos C}{Ky + \left[\dfrac{Rm}{T}\right]^2 Kz} \quad \text{(3)}$$

in which Ky and Kz (both functions of angle C) may be taken directly from Figures 4 and 5, respectively.

The plus-or-minus sign of formula (3) is to be regarded as a plus sign if a fall in temperature is being considered and as a minus sign if a rise is being considered. As the volume change (shrinkage or expansion) taking place in concrete while setting and curing is similar to the volume change resulting from a temperature change, all that will be necessary, in order to take into account the effect of the setting-and-curing shrinkage or expansion of the arch dam, will be to vary, in due proportion, the value of t in formula (3). On page 43 of the third edition of "Design and Control of Concrete Mixtures," a pamphlet issued by the Portland Cement Association, is a chapter on "Shrinkage and Expansion of Concrete" that the reader may find of interest in determining the proper value of t.

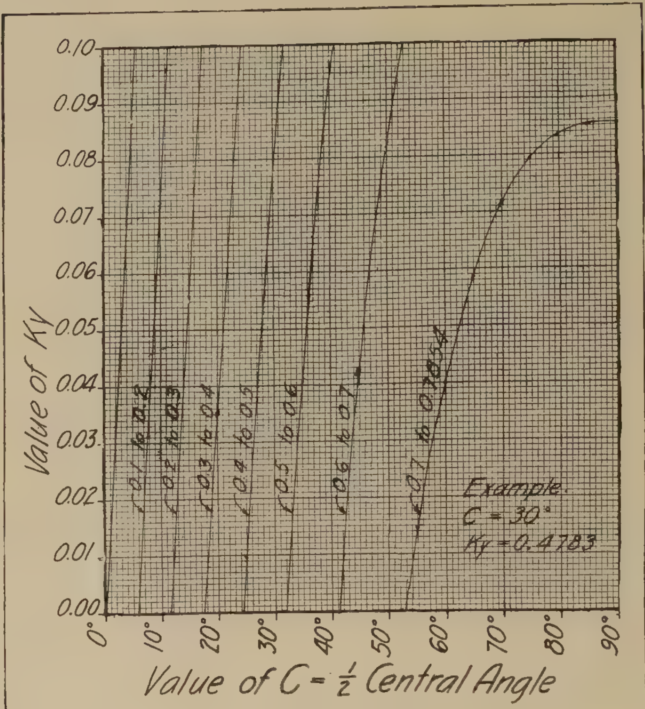


FIG. 4

If it is desired to find the unit fiber stresses at the "crown" section or at the end sections only, it will not be necessary to draw an "elevation" of the arch, as the value of V in those cases may be found by the following formulas:

$$V \text{ at "crown" section} = \left[1 - \frac{\sin C}{C}\right] Rm \quad \text{(4)}$$

$$V \text{ at end sections} = \left[\frac{\sin C}{C} - \cos C\right] Rm \quad \text{(5)}$$

Strictly speaking, it will not be necessary to draw an

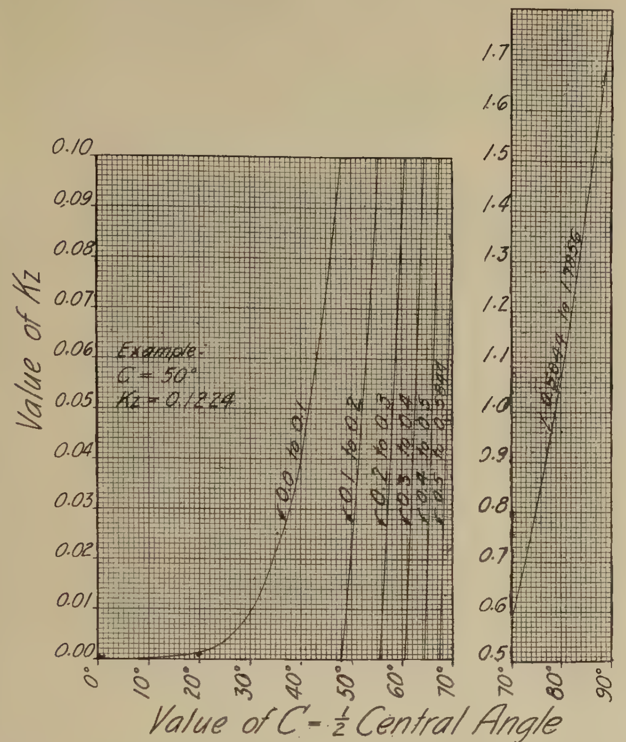


FIG. 5

"elevation" of the arch in order to find the fiber stresses at any section, as the value of V for any section is equal to $[\sin B - (\sin C \div C)]Rm$ if all resulting negative values are considered to be positive.

The values of Kx, Ky, and Kz shown in Figures 3, 4, and 5, respectively, have been calculated by using the following formulas:

$$Kx = 1 - \frac{\sin C}{C} \tag{6}$$

$$Ky = \tfrac{1}{2}\,(C + \sin C \cos C) \tag{7}$$

$$Kz = 12\left[-\frac{\sin^2 C}{C} + \tfrac{1}{2}\,(C + \sin C \cos C)\right] \tag{8}$$

The unit shear v at any section $c\text{-}d$ may be found by applying the following formula

$$v = \frac{3\,H \cos B}{2T} \tag{9}$$

In applying the foregoing formulas care should be taken that similar quantities are expressed in the same unit; i. e., if Rm is expressed in feet, T should also be expressed in feet, and so on.

Delivering 60,000 Cubic Yards of Concrete

(Continued from page 22)

means of a bucket crane, a stockpile of approximately 300 tons being maintained over the tunnel.

One belt serves to feed the three overhead aggregate bins, a tripper diverting the flow to the desired bin. Each of the three bins holds approximately 200 tons of material and may be drawn upon at will from any of the three mixers under inspection.

Approximately 3,000 tons of sand and gravel are handled at this plant every day. Cement is purchased in bulk and is fed either directly to the overhead bin from which it is weighed into the batch hoppers, or to a 200-barrel concrete storage tank, by means of a Fuller-Kinyon pneumatic pumping system. A normal day's operation will require approximately 2,000 barrels of portland cement. Six men, working three to a 10-hour shift, will handle this material without difficulty. In fact, 17 or 18 men, including firemen and boat cleaners, are all that are required to keep this plant operating at capacity.

Three Mixers Used

At the Berks Street plant three concrete mixers are in constant operation. One and one-half minutes mixing time is specified for each batch, the mixing being controlled by a timing device. Two Ransome 2-yard mixers and one 3-yard Smith tilting mixer are used, and this equipment is capable of turning out from 1,500 to 1,800 cubic yards of concrete per day. During the month of August more than 30,000 cubic yards of concrete were delivered from this one plant, and more than 60,000 cubic yards total was furnished to various jobs by the company from its several plants.

Orders Transmitted to Plant on Ticker Tape

Orders are received over direct wire from the main office after having been checked by the engineering department. They are transmitted to the concrete plant over a direct wire and to the mixer control room over a ticker tape, each order stating the mix, the amount of concrete required, location of the job, the time delivery is to begin, and the desired interval between loads, and it is up to the dispatcher to see that schedules are met. Ordinarily it takes from 30 minutes to an hour for a truck to make a round trip, depending upon the zone in which the operation is located.

Delivering the Concrete

As each driver leaves the mixer, his truck is sealed and the drum started rotating. He then gets the delivery ticket bearing the certification of the inspector that the truck contains the specified mix properly proportioned by weight as to cement, sand, gravel, and water, and then proceeds directly to the job, bringing back a receipt for delivery. On returning to the yard each driver is required to wash out and clean the tank of the truck and then report in line for another load. Edward Stohner, superintendent of the Berks Street yard and concrete plant, who has spent his life on large concrete operations, sees to it that everything moves with the precision seen on the best conducted large operations. Herbert J. Whitten is superintendent of the Philadelphia retail yards, and has control of the four centrally mixed concrete plants.

The Selling Organization

Charles Shoemaker, vice-president in charge of Philadelphia retail operations, has fourteen men, specially trained in selling building materials, out every day, and it is his responsibility to see to it that the concrete plants and retail yards are kept busy. The concrete is sold either on a strength basis or in accord with individual specifications, the wide variety of mixes which the company makes making it possible to do this without inconvenience. Preference is given, however, to sales on the strength basis. Deliveries are made on a zone basis, the charges being graded to agree with those in force for similar delivery of dry materials.

H. J. Knopel, well known in the East as a concrete engineer of wide experience, keeps a check on all specifications for concrete, supervises concrete research conducted by the company, and co-operates with the engineers, architects and contractors.

Public Works and Concrete Paving Construction Holding Up Well

Paving Contracts Exceed 110,000,000 Sq. Yd.—Building Construction Doing Moderately Well—Total of All Construction 19 Per Cent Below Last Year

CONTRACTS for concrete road construction and for public works and public utilities continued to be the bright spots in the construction industry. Awards for concrete highways made during August amounted to 7,242,839 sq. yd., compared with 7,009,910 sq. yd. awarded in August, 1929. Street and alley paving awards again fell below the corresponding month of last year.

Total Pavement Awards Holding Up Well

The Portland Cement Association reports the total concrete pavement awards, including highways, streets and alleys for the first eight months of this year and last year, at the following figures:

SQ. YD. OF CONCRETE PAVEMENT AWARDED IN FIRST EIGHT MONTHS OF YEAR

	1929	1930
Roads	69,200,671	84,954,327
Streets	31,870,090	24,154,834
Alleys	2,401,639	1,784,141
Totals	103,472,400	110,893,302

Construction Contracts Below Last Year

Although contracts for construction work for public utilities and public works departments were slightly higher in August than in the corresponding month of 1929, contracts for construction work in general were below last year. The F. W. Dodge Corporation reports the following contracts awarded during the month, in the 37 states east of the Rocky Mountains:

CONSTRUCTION CONTRACTS IN AUGUST

	1929	1930
Buildings	$369,594,600	$223,116,200
Public Works and Public Utilities	119,287,800	124,202,100
Totals	$488,882,400	$347,318,300

During the first eight months of 1930 total contracts reported by the Dodge organization amounted to $3,352,860,000, compared with $4,156,865,000 in the first eight months of 1929.

Contemplated Construction

Contemplated construction in the 37 states east of the Rocky Mountains was reported at $455,478,400, compared with $657,832,000 in August of last year.

Concrete Floors Keep Out Termites

The dreaded white ants, or termites, are not so much of a problem in Cuba, where builders know how to keep them out of buildings. On this subject an official of a cement manufacturing company writes:

> Happily we, in Cuba, are not confronted with much competition in connection with residence construction, particularly as regards floors, because all floors are made of concrete, most of them being covered with a decorative cement tiling.
>
> Termites in Cuba, known locally as "comejen," attack wood, and they are very destructive and dangerous, because they get into the interior part of the wood, leaving the shell untouched. Then, too, the moist, humid climate of Cuba is not particularly conducive to long life of timber, except the native hardwoods that are expensive and hard to handle from a carpenter's point of view.

Reinforcing Program

The tentative program of the Concrete Reinforcing Steel Institute, to take place October 20th to 22nd at Briarcliff lodge, Westchester County, N. Y., announces that the first event will be the meeting of the board of directors, followed in the afternoon by regional conferences and the opening session. The general subject of the latter will be "Stabilization."

The report of the forms department to be given by Louis Aronstam, chairman, governing committee, will be heard the following day.

Personals

S. C. Hollister, consulting engineer, Swarthmore, Pa., has been appointed professor of structural engineering at Purdue University, succeeding Prof. E. L. Eriksen, who goes to the University of Michigan as professor of engineering mechanics. Prof. Hollister is a member of the Joint Committee on Concrete and Reinforced Concrete. He is a graduate of the University of Wisconsin and formerly taught engineering at the University of Illinois. Prof. Eriksen is a graduate of the University of Copenhagen.

Prof. A. Diefendorf, head of the civil engineering department of the University of New Mexico, has been appointed associate professor of civil engineering at the University of Pittsburgh. Before going to the University of New Mexico three years ago, Prof. Diefendorf taught engineering at the University of Illinois. He is a graduate of Ohio Northern University.

John J. Cone, president of Robert W. Hunt Company, and a member of that company since its organization in 1888, has retired. *C. B. Nolte*, vice-president and general manager, has been elected president and general manager of the company, with headquarters at the general office, Chicago. *J. C. Ogden*, a director and eastern manager of the company, has been elected vice-president, with headquarters at New York City.

A. J. Joyce has accepted the position of assistant to the president of the Material Service Corporation of Chicago, according to announcement made by Henry Crown, president. He began his duties September 20th.

Mr. Joyce was for twenty-four years connected with various subsidiaries of the United States Steel Corporation, including the Universal Atlas Cement Company.

W. J. Coles, director in charge of the engineering and cement manufacturing machinery department of Edgar Allen & Co., Ltd., Sheffield, England, has sailed for the United States and Canada for a two months' tour for the purpose of studying engineering and cement manufacturing methods. His American address will be in care of the Edgar Allen Steel Co., Inc., 741 Washington St., New York.

How to Save in Concrete Form Work

Advantages of Longer Hatchway Openings—Order of Assembly—Soffit Details—Concrete Placing and Finishing—Types of Risers

X—Forms for Concrete Stairs

By A. B. MacMILLAN
Chief Engineer, Aberthaw Company, Boston, Mass.

CONSTRUCTION of form work for concrete stairways is more or less of a bugbear with carpenter foremen who have had limited experience in this direction. The supposed difficulties prove to be largely a mental "hazard" when the problem is completely analyzed by a careful study of the details.

The Stairway Problem Analyzed

Assuming a stairway of the type illustrated in the layout in Figure 49, the problem may be considered as comprising the construction of two reinforced concrete stair landings at levels intermediate between floors, with three short runs of stairs connecting the landings to each other and to the previously constructed floors.

The stair landings are likely to be either a slab or of light concrete beam-and-slab construction supported on reinforced concrete posts; or several edges of the landing slabs may be supported on recesses in the stair enclosure wall. Supporting posts along the inner edge of the stairway may be omitted by replacing them with irregular reinforced concrete beams or girders extending from one stair enclosure wall to the other.

Regardless of the type of construction of the stair landings or their supports, these structural details will clearly be shown on the working plans for the building. Provision will have been made for supporting this construction at the time the previously completed concrete floors and walls were built. In consequence, the details and discussions in this article need be concerned only with the form work for the stair runs themselves. Forms for the landings and their supporting posts or girders will be built in the manner described and illustrated in previous articles.

Length of Rough Opening

It will be fortunate if the hatchway openings in the rough structural concrete floors have been left about 8 in. longer, measured horizontally, than the horizontal distance between the faces of the first and last risers. Reference to Figure 50 will help the reader to see the advantages of the longer opening. As the drawing shows, the faces of the top and bottom risers (at the connection with the previously built floors) are several inches in from the face of the hatchway opening in the floor construction.

The arrangement just described has several distinct advantages. In the first place, it allows sufficient play for adjustments necessary because of inaccuracies in the floor

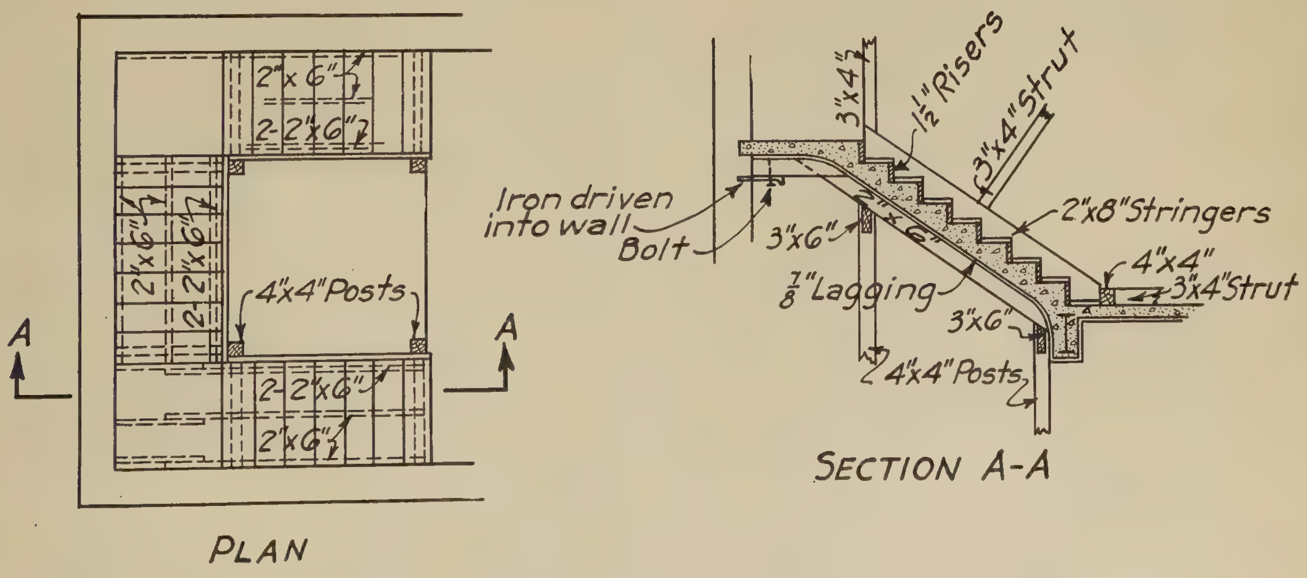


FIGURE 49 - LAYOUT OF STAIR CENTERING

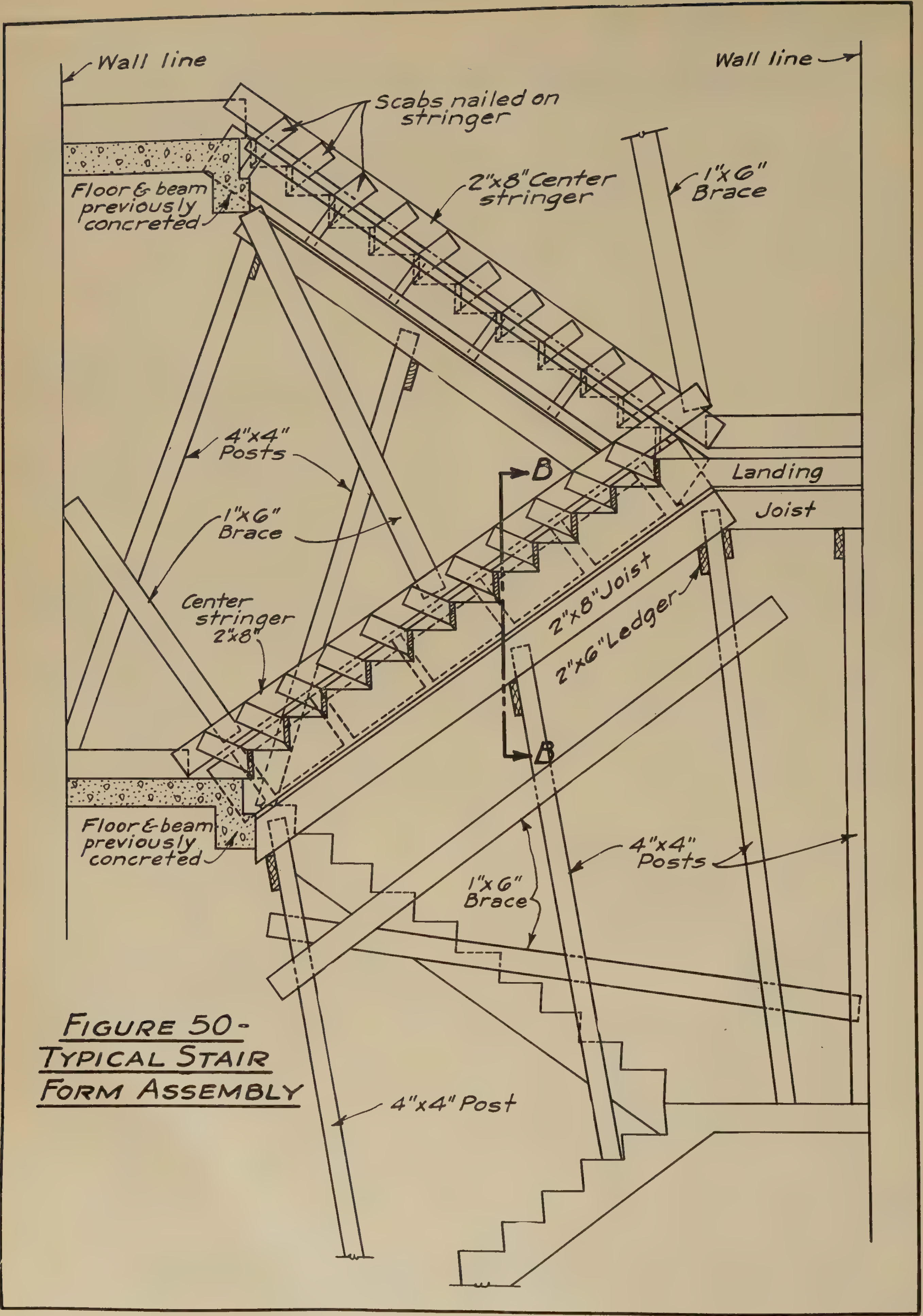
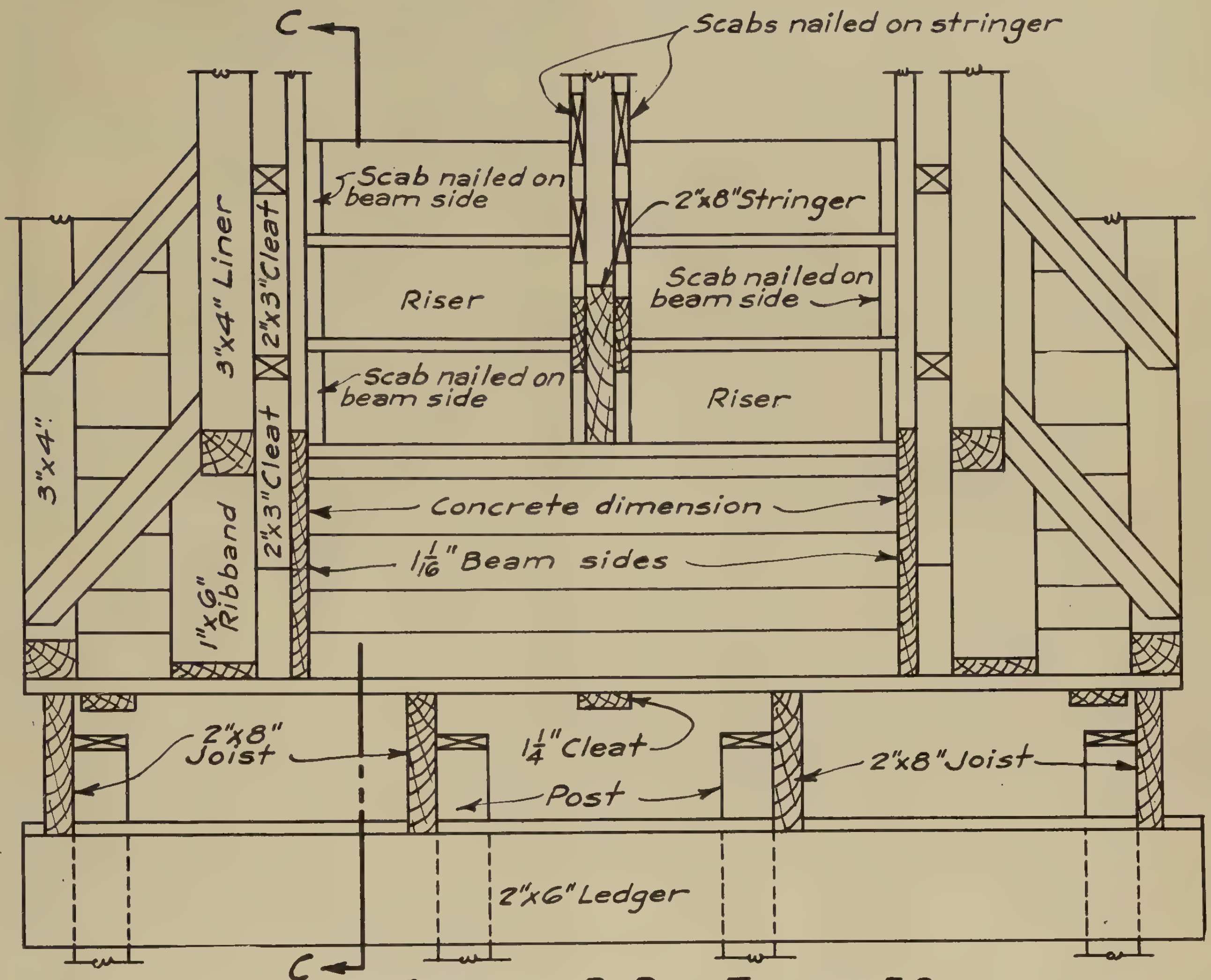


FIGURE 50—TYPICAL STAIR FORM ASSEMBLY



SECTION B-B IN FIGURE 50

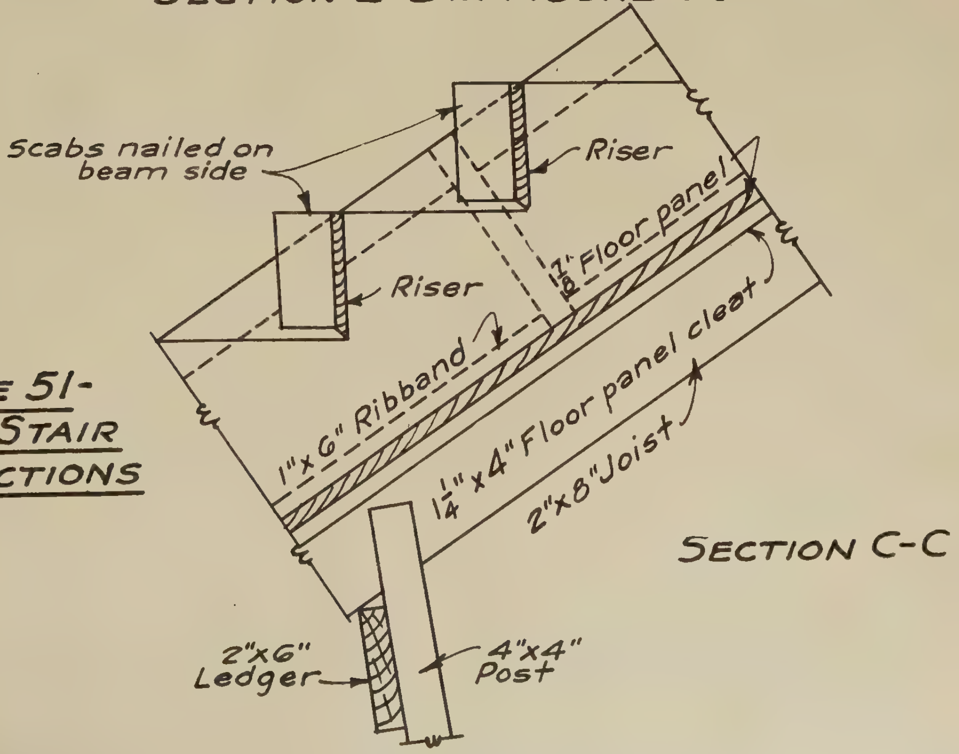


FIGURE 51- TYPICAL STAIR FORM SECTIONS

construction. It permits a better finish at the top of the run than if the face of the hatchway opening were utilized as the top riser. It also permits setting of all safety treads at the time the stairway is concreted, whereas if the face of the hatchway opening were used as the top riser it would be necessary to set the topmost safety tread at the time when the floors are concreted.

Build Landing Forms First

The form work for the stair landings must be built first, for they will be required to help support the sloping form work for the stair runs. As stated above, the form work for the landings and their supports need not be described or detailed here, because it is similar to the work shown in former articles in connection with form work for floor slabs, beams, walls and columns.

The Order of Assembly

The form work illustrated in Figures 50 and 51 will now be discussed, to assist the reader in understanding the details. The stairway here shown has one landing only, midway between floors and extending the full width between the walls comprising the stair enclosure.

The Soffit Panel

The soffit panel is the sloping panel that forms the underside of the stair run. It is the first to be placed after the form work for the stair landings is in position. This panel, as a unit, consists of 7/8-in. lagging placed parallel to the risers, and held by 1¼ by 4-in. cleats (see Figure 51). The cleats are spaced so as to avoid the 2 by 8-in. longitudinal joists which support the panels. These joists, in turn, are supported on 2 by 6-in. ledgers spiked to 4 by 4-in. posts. The entire assembly is well braced with 1 by 6-in. material, the posts being set on the newly completed stair runs and landings below. All completed stairs and landings, naturally, are kept shored as long as necessary.

The length of the soffit panel is best determined from a layout made by the carpenter foreman after measuring the exact horizontal length of the hatchway opening in the structural concrete floors. By means of a large-scale layout the position of the soffit panel at each end of the stair run may be determined by scaling, to a reasonable degree of accuracy.

Stringers and Beam Sides

Following the assembly of the soffit panel and its supports, the form work consisting of stringers, beam sides and risers must be placed. The details here required will depend, of course, on the nature of the construction.

On the free edge of a stair run there may be a small beam extending from landing to landing or from landing to floor. This will require a form for the sides and bottom of this beam. In the more usual case there is no beam extending below the soffit, in which event the soffit panel extends to and beyond the edge of the stairs and only a beam side is provided. This latter detail is shown most clearly in Figure 51, where the beam side is seen to consist of 1 1/16-in. dressed material.

A common practice is to notch out the beam sides just described, to fit the requirements of the risers. This is a wasteful and unnecessary practice, for the same purpose may be accomplished by nailing short 1-by-6 scabs to the beam sides, as shown in both sections B-B and C-C in Figure 51. This leaves the beam sides available for later uses.

On the wall side the stair concrete is to be in contact with the wall, so that there is no room for a stringer or a beam side plank at the side of the stairway. In this case we place a 2-by-8 stringer against the wall, just above the risers, again nailing scabs against the stringer to provide a means of holding the risers. Here again we avoid notching the stringer, as a result of which it is available for further use. A similar stringer, to which scabs are nailed in a similar manner, is placed above the center line of the run of stairs. These details are shown in Figures 50 and 51, the center stringer being illustrated most clearly in the upper part of Figure 51.

Placing the Concrete

The consistency of the concrete for a stair run must of necessity be a compromise between a mixture that is dry enough to be placed on a steep slope, and one that is slushy enough to be worked around the steel reinforcement of the stairway slab. A good plan is to use a 1:3 cement-and-sand mortar, or a concrete mixture with small coarse aggregates (not exceeding the ½-in. size), for that part of the slab below the steel reinforcement. This comparatively fine mixture can be worked around the reinforcement with a fairly dry consistency. The rest of the slab and the steps themselves may then be made of ordinary concrete of dry consistency, tamped into place.

Another practice occasionally followed is to use small-sized coarse aggregate, either pea gravel or crushed aggregate not exceeding the ½-in. size, for all the concrete in stairway work. Usually, however, the use of a special size of aggregates is not feasible unless the quantity of stair construction is large enough to justify the purchase and delivery of special material for this purpose. In ordinary cases it is best to use the regular materials, but to take extra care in working the rather dry mixture around the steel.

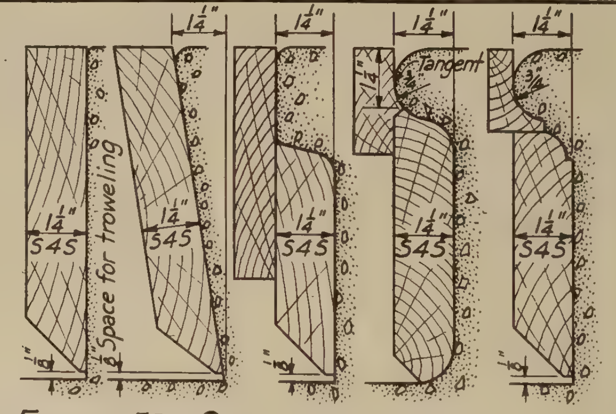


FIGURE 52 - QUARTER SIZE DETAILS OF TYPICAL STAIR RISERS AND NOSINGS

Height and projection may vary

Finishing

About the only special precaution to be taken in connection with the finishing of stair work is to see that the riser form is beveled at the bottom and that a ⅛-inch clearance is left beneath it, so that the finisher can trowel the tread all the way back to the face of the riser. Tools must of course be at hand to finish special types of nosing.

Types of Risers

Various types of forms for risers are illustrated in Figure 52. The bevel at the bottom and the ⅛-inch clearance, to facilitate the finishing of the tread, are shown. These various types, made for the most part of 1¼-inch dressed material, are clearly illustrated in Figure 52, and need no further comment. It is necessary only to point out that the scabs nailed to the stringers and beam sides, previously discussed (and shown in Figures 51 and 52), must be cut to fit the particular riser form in use.

Shoring

The most convenient place to set the posts and props supporting stairway form work is on the newly concreted stairway and landings immediately below. It is therefore necessary to keep the stairs and stair landings shored until the concrete has attained a high strength. A good practice under ordinary weather conditions is to leave the shoring timbers in place until the concrete is 14 days old. During cold weather a longer time may be required. In any case the wise construction superintendent will follow his usual practice of keeping shoring timbers in place until he knows that the concrete is strong enough to carry the construction loads likely to be imposed upon it.

Determining the Constituents of Hardened Concrete

Chemist Combines Methods Developed by Burke and Kriege—Former Method Analyzes Aggregates, Latter Determines Ratio of Cement to Aggregates—Not Dependable with Some Types of Cement—Detailed Methods Given

By A. K. LIGHT, B.Sc.
Chemist, Testing Laboratories, Department of Public Works, Ottawa, Canada

IT is frequently of great interest, especially in the case of failures, to know the type and proportions of the various constituents, viz., cement, sand, gravel or broken stone, entering into the composition of the concrete. At present in our department records are kept of all these data, but unfortunately in past years, and even at present in works not under our jurisdiction, no records are kept. Thus when it is desirable to know the mixture in any given specimen of concrete, mechanical and chemical examinations are resorted to in an endeavor to arrive at the necessary data.

The examination and separation of a piece of concrete into its various constituents, at first thought, seems comparatively simple, but upon consideration proves to be extremely difficult. In the first place, the sample may not truly represent the mass of the concrete, for due to segregation of aggregates, non-uniformity of batches or variations in placing, the homogeneity of the mass may vary greatly. However, examination, as far as practicable, of the mass, and a careful selection of a large composite sample taken from the various parts of the concrete, may obviate this variation to a great extent. The next problem is in the actual chemical composition of the constituents themselves, for they all contain silica, ferric oxide, alumina, lime, magnesia, the alkalies and small amounts of other substances, in varying proportions, and though it is easy to determine the amount of these compounds "in toto" in the concrete, it is very difficult to apportion them to the cement and aggregates constituting the concrete.

Burke's Method

The method given in Bulletin 61 of the Iowa State College, "Estimation of the Constituents of Portland Cement Concrete," by Geo. W. Burke, goes a long way towards solving the problem, but offers many pit-falls, and is only accurate under certain well-defined conditions. It is, however, well worthy of consideration and gives results which are at least approximate.

An outline of the method is as follows:

The original large representative sample is carefully broken into 2 in. or smaller pieces and reduced to one of about 1,000 to 1,500 grams, which is heated in a muffle furnace for about 3 hours at a temperature of about 600 to 700 deg. C. Dehydration of the cement takes place at this temperature allowing the coarse aggregate to be separated by hand from the sand and cement, and cleaned by brushing and scraping. Separation is then made on the ¼-in. sieve, the portion passing being classified as the "sand-cement mixture." Part of this mixture is analyzed for silica and lime, while the balance is used to obtain, as nearly as possible, a representative sample of the original sand. This is obtained by rubbing the mixture in a mortar with a rubber-faced pestle and sieving until the sand portion is free of cement. This sand is then analyzed for silica, and lime, and by making calculations with the percentages of either of these constituents in the sand-cement mixture, and also the assumed percentages in the cement, the proportions of sand and cement in the mixture may be arrived at.

The pitfalls and possible sources of error in the method as found by ourselves, and borne out by H. F. Kriege of the State Highway Commission, Jefferson City, Mo., and L. G. Carmick of the Division of Tests, U. S. Bureau of Public Roads, may now be discussed.

In breaking down the original sample to 2-in. size it is difficult to prevent the breaking of the aggregate also especially if it is soft. At a temperature of 600 to 700 deg. C. limestone and dolomite are liable to be partially calcined, become friable, and thus break down readily with the rubbing, going into the sand-cement mixture or even into the discarded cement portion, and thus impairing the results. Similarly, gravels of other origins may disintegrate somewhat at this temperature due to expansion stresses, expulsion of water or unsoundness due to weather-

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Paper read before Ottawa branch of the Society of Chemical Industry and published in the August (1930) issue of *The Journal* of the Engineering Institute of Canada.

ing. If a lower temperature is used the cement is not completely dehydrated and is difficult to separate from the aggregate. The complete separation of the sand, especially in the fine particles, is difficult to achieve and is another source of error. The presence of rotten or weathered aggregate is a very common occurrence and the percentage often runs high. This material is very friable, as a rule, especially after heating at the temperature used here.

Where the sand is non-calcareous and little affected by dilute hydrochloric acid, great improvement in the results is obtained by washing the separated sand with dilute acid in order to remove any adhering cement.

To sum up: In order to obtain accurate results by this method the aggregates, both coarse and fine, must be resistant to the temperature used, must be sound and not easily crumbled, and not appreciably affected by hydrochloric acid. Otherwise the results will be vitiated in proportion to the extent that these requirements are not fulfilled. In any case it is most necessary to use every care and precaution in carrying out the method in order to obtain the best results.

Kriege's Method

A method which gives the ratio of cement to aggregates, but does not give a separation of the aggregate has been proposed by H. F. Kriege, already mentioned. We have checked this method in many ways by the use of known mixtures of cement and aggregates of different types and have found it to give very good results. We have also used it in checking the cement content of some concretes which showed signs of disintegration in a very short time after being placed, in order to ascertain whether the contractor made the mix as rich in cement as specified.

This method is based on the difference in the state of combination of the silica in the cement and in the aggregate. In the former it is present as mono-, di-, and tricalcium silicates, while in the latter it is present either free or combined as some impure aluminum silicate. The silica may therefore be separated from the calcium silicates by chemical treatment which will have little or no effect on it either in the free state or combined in the aluminum silicates. The only types of portland cement concrete we found that failed to give us dependable results under this method were those which contained either diatomite or basic slag or similar materials. The bulk of the silica in diatomite is readily soluble in alkali, while the basic slags liberate silicic acid upon treatment with dilute hydrochloric acid.

Strict precautions must be taken in the procuring and preparation of the sample as with the method already described. The ultimate sample taken for analysis should be ground to pass at least a 100 mesh sieve, and care should be taken that none is lost during the grinding.

The method of analysis is as follows:

Weigh triplicate samples of 10 grams into 250 c.c. beakers, moisten with hot water and stir to prevent the formation of lumps. Add slowly, with thorough stirring, 100 c.c. of 1:3 hydrochloric acid, and after all effervescence has ceased, allow the mixture to settle until the supernatant liquid is clear. Decant through a prepared Gooch crucible, retaining as much of the residue as possible in the beaker, and wash the residue with hot water, twice by decantation. Add 75 c.c. of a 4 per cent solution of sodium hydroxide to the residue and heat to about 75 or 80 deg C., stirring constantly. Hold the mixture at this temperature for 10 to 15 minutes and then allow to settle. Filter and wash by decantation through the same Gooch crucible into the acid solution previously filtered. Finally transfer all the residue to the crucible and wash thoroughly with hot water. The suction on the Gooch crucible should be regulated so that filtration is not more rapid than a dropping rate. Quantitatively transfer the solution from the filter flask to a suitably sized beaker and evaporate the solution to dryness. After baking on the hot-plate, moisten the residue with concentrated hydrochloric acid, evaporate and bake again. Take up the residue with about 75 c.c. of 1:4 hydrochloric acid and boil until all soluble material is in solution. Filter, wash well with both hot dilute hydrochloric acid and hot water and finally ignite the residue in a platinum crucible and weigh. Moisten the residue with a few drops of concentrated sulphuric acid, and add 10 to 15 c.c. hydrofluoric acid. Evaporate to dryness, ignite and weigh again, the loss in weight representing the silica liberated from the cement in the original concrete mixture. This weight divided by the average silica content of portland cement—about 21.5 per cent—gives the percentage of cement in the original concrete.

Combining Both Methods

The first method described has the advantage of allowing an examination of the aggregate being made; its petrographic nature, granulometric analysis and other physical properties may be determined. The second method offers a means of determining the proportion of cement to aggregate. By combining these two methods it is possible to arrive at a fairly accurate means of making a thorough examination of a specimen of concrete and of determining fairly closely the proportions of the mix used in its making, subject, of course, to such vitiating circumstances as have already been described. One of the chief controlling factors in determining the strength of concrete, is the amount of water used in proportion to the quantity of cement, and it is unfortunate that there is no method of determining how much of this all-important constituent was used in making the concrete. However, such data as the strength and density of the concrete, nature and grading of the aggregate, and quantity of cement should go a long way towards solving the problem of why the concrete failed.

Too much importance cannot be placed on the value of such information as may be acquired from these methods, not only from the point of view of checking up on the contractor, but from the fact that the knowledge of the causes of a failure may obviate a recurrence of the same conditions in future structures.

Cast Stone Freight Rate Hearing Scheduled for October

The Interstate Commerce Commission hearing on cast stone freight rates will take place on October 14th, after having been postponed from September 3rd upon request of the carriers.

Careful preparations are being made for a forceful presentation of the case of cast stone manufacturers, the Cast Stone Institute announces. Testimony on behalf of the industry from the viewpoint of the manufacturer will be presented by C. Van de Bogart, Herman Frauenfelder and Ernest A. Wiedemann.

Iowa Leading in 1930 Pavement Placed

With 700 miles of hard-surfaced road already laid, Iowa takes the lead among states in the amount of pavement placed this year.

At the end of every working day Iowa road builders have turned out no less than 4 miles of concrete pavement. Altogether some $33,000,000 will be spent this year in improving Iowa roads. Three hundred twenty-five miles remain to be placed in 1930.

Getting Ready for 1931

Contractors Applying New Methods and Equipment Toward Lowering Unit Production Costs — Problem Similar to That of Manufacturers—Products Manufacturers Developing New Uses and Expanding Sales Area —Each Local Market Has Special Opportunities

THE man who gets the cream of the concrete construction business in 1931 is the man who is now thinking about it and getting ready for it. This is true more especially of contractors and concrete products manufacturers.

The forward-looking contractor is now working out new ways of reducing his construction costs, by applying the new ideas and methods he has gathered up during the last twelve months in his daily contacts and in the things he has read. He is accomplishing these cost reductions by applying more system and standardization in his concrete form work, by employing new methods in the handling of materials and the distribution of concrete, by paying more attention to his construction job layouts, by keeping his old equipment in better condition and replacing worn-out equipment with new. He is working toward the use of labor-saving devices and equipment to a greater extent than ever before.

When activity in building construction is again under full swing, as inevitably it will be in due time, this contractor and others like him will get the cream of the work for the simple reason that their unit costs will be on a new basis, at a lower level than formerly.

These progressive contractors will have reduced their unit production costs in much the same way that manufacturers employ in reducing their costs, namely, through the use of new methods and equipment that lower the cost of handling and placing materials. The old line contractors who are slow to learn about new ideas and methods, and unduly conservative about accepting them when they do learn about them, will continue to do things in the same old way. They will not be in on the most desirable contracts in 1931.

Manufacturers of concrete masonry building units, on their part, are considering new uses and wider markets for their products. They see new uses for ordinary wall and partition units in the trend toward the employment of these materials in large buildings where other materials have until recently held sway. The more alert and progressive products manufacturers are pushing this market in their respective communities to the limit of their ability, not hesitating to call for aid from their organized associations.

Other new possibilities are seen in the development of local markets for special products made of concrete, but which, in that particular community, have been supplied in materials other than concrete. Among these are ornamental concrete specialties such as fireplaces, interior tile work, colored floor and sidewalk tile and related products.

Cast stone is making rapid progress in some localities where it is being used extensively as exterior trimstone and as wall facing in monumental structures.

Wherever definite progress has been made in any of the directions just mentioned the story is always the same—some man or group of men possessing genuine business acumen has entered the concrete products manufacturing field and has made a study of the potential market. These men have even brought the expression "shipping radius" into the vocabulary of the industry, for in some instances a considerable part of the year's business consists of material shipped to surrounding towns and cities by railway freight or motor trucks. The development of light-weight building units and ornamental products has made this possible.

Products manufacturers with an eye to the future are continually experimenting with new ideas, with the view of expanding the range of use for concrete products. Several representatives of CONCRETE recently visited a products plant in a city of 60,000 population, where the manager was experimenting with a new process that, when perfected, will produce a dense, glossy finish at once, without requiring mechanical polishing. His interest in that process arises from the fact that the city in which he is located is a state capital and the seat of the state university. In consequence, large buildings are almost continually under construction for the state government or the university, while club and fraternity buildings, hotels and office buildings are being built in much greater numbers than in the average city of this size.

In a word, he sees a generous market for such a product because of the special situation prevailing in his city.

The plant manager just mentioned has already established a cast stone market on a firm basis in his community, a fact which demonstrates his ability to judge his market.

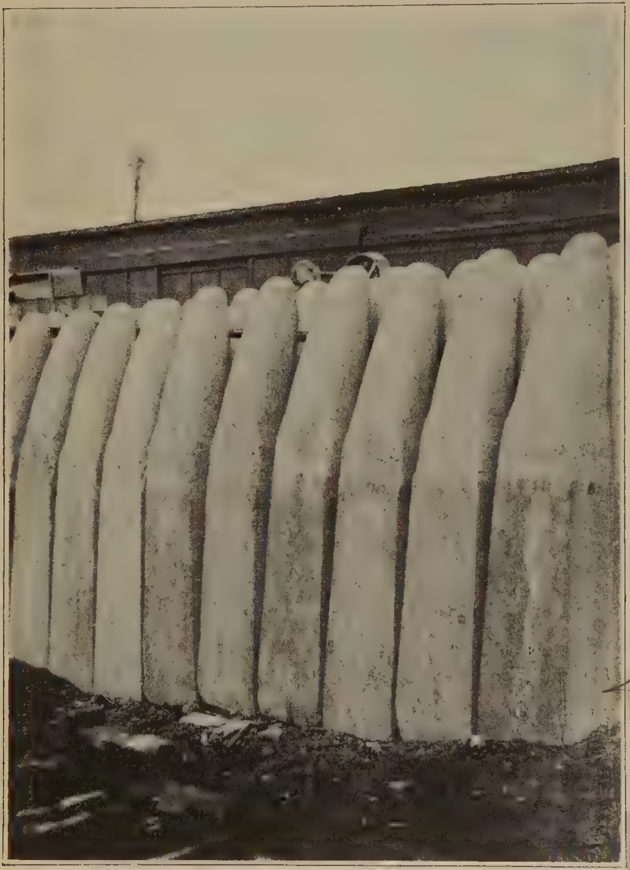
Finally, who are the contractors and the products manufacturers who keep in step with new methods and new materials and markets? Obviously they are men who are alert and receptive to new ideas, and who have the ability to distinguish between new ideas that have practical value and those of little consequence. They keep in touch with their trade associations. They are men who read their trade and technical papers, for through those publications they are the first to learn of the trend toward new developments and the details concerning them. It is in these ways that these men keep several years ahead of their more sluggish competitors.

How Concrete Parkway Posts Are Made by Highway Department

Connecticut State Highway Department Manufactures Posts at Portland, Connecticut, Plant

By DONALD C. CHURCH
Connecticut State Highway Department

In the summer of 1927 the Connecticut State Highway Department experimented with designs for parkway concrete posts for use on park sites being developed in connection with the general highway construction program, and adopted the posts now in general use. This post is manufactured at the highway department's plant in Portland, along with concrete boundary and random markers for turnpike layouts, concrete posts for directional and warning signs, concrete cribbing ties and concrete drainage markers.



Stock pile in casting yard where posts are made

The "horn" of the post is 15 inches long and 7½ inches in diameter where it joins the base, which is 4 feet long and 9 inches square, the total length of the post being 5 feet 3 inches.

The reinforcement consists of four ½-inch round bars, 4 feet 4 inches long, placed 1½ inches from each corner. A 1-inch pipe extending through the post is placed 40 inches from the foot of the post to facilitate handling and setting in the ground. The concrete is a standard 1:2:3 mix of portland cement, sand, and ½-inch trap rock.

The forms, which are thoroughly greased before using, can be removed in 48 hours if necessary. The first form used for this work was made entirely of wood, but later ten cast iron forms for the horn or head were made up from a wood model and these placed inside the wood form which shapes the base.

Some of the parkway posts in service on Connecticut state highways

Before the concrete is thoroughly cured the horn of the post, the only part remaining above ground after it is set in place, is finished off with a bush hammer, which brings out the color of the natural stone in the post.

The average cost of the 2,123 park posts which have been made to date is $1.49 each.

Freshly Made Cement Is Proved No Cause for Worry

Research Station Finds Hot Cement Has No Effect on Concrete—First Concrete Test Pieces Made With Cement at 248 Deg. Fahr.—Setting Time Shorter With Higher Temperatures

The use of freshly made cement while still hot is permissible in concrete work, according to results obtained during an extensive series of tests reported by N. Davey in Building Research Bulletin No. 7, published in July under the title of "Hot Cement"[1] by the British Department of Scientific and Industrial Research.

The investigation was made as a result of the growing practice of shipping cement direct from mills to large construction jobs. Such shipments are often made from freshly manufactured lots of cement instead of taking older cement from storage. It often happens, therefore, that the cement on its arrival at the construction site is appreciably hot to the touch. Doubt exists among many contractors as to the advisability of using cement in such a condition. Tests were accordingly decided upon and were conducted in collaboration with one of the leading manufacturers of portland cement.

Take Samples Direct From Grinding Mills

Samples of cement were taken immediately after the finished product had left the grinding mills. On the conveyor belts which carry the cement from the grinding mills to the storage silos the temperature of the material was observed to be 284 deg. F.

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[1] Copies of the complete bulletin may be obtained at four pence each from the Director of Publications, His Majesty's Stationery Office, London, England.

The first tests for setting time and the preparation of sand-mortar briquettes were made in the testing laboratory at the cement mill, the mixtures having been made when the cement was only half an hour old. The temperature by this time had fallen from 284 to 252 deg F., but this temperature was still much in excess of the temperature which cement is likely to have when it reaches a construction site.

Both the initial and the final setting of the neat cement specimens were measurably shorter with the higher temperatures. The initial set, for instance, ranged from 1 hr., with the temperature at 252 deg. F., to 2 hrs. 55 min. with the cement cooled to normal temperatures. The corresponding range in final set was from 2 hrs. 25 min. to 4 hrs. 15 min.

Ship Hot Cement in Special Containers

For the tests other than setting time and mortar briquettes, cement collected at the mill at a temperature of 284 deg. F. was shipped to the Building Research Station. This supply of cement was shipped in specially made containers and vacuum flasks, so that it reached its destination without a serious loss of heat. This enabled the investigators to repeat, at appropriate intervals, the tests made at the cement mill's laboratory. The first series of concrete test pieces was prepared at the Building Research Station when the cement was only four hours old, when its temperature was 248 deg. F.

The accompanying table gives the compressive strength of 1:2:4 concrete made with cement at the various temperatures indicated. The corresponding ages of the cement are given as a matter of record, though it should be remembered that during the progress of making test specimens the cement was kept stored in airtight containers. In consequence, the rate of cooling was far slower than under the conditions prevailing in ordinary storage.

COMPRESSIVE STRENGTH OF 1:2:4 CONCRETE PREPARED FROM HOT CEMENT

Age of cement*	Temperature in degrees Fahr. Cement alone	Temperature in degrees Fahr. Mixed concrete	Compressive strength in lb. per sq. in.† 3 da.	7 da.	28 da.
3¾ hrs.	248	82	488	980	2,382
18 hrs.	86	73	579	1,083	2,687
3 da.	66	64	522	908	2,415
8 da.	59	59	485	1,003	2,564
14 da.	57	57	410	957	2,504

*Cement was kept in airtight storage and cooled more slowly than under ordinary storage conditions.

†Each compressive strength value is the average of six specimens.

The table shows that in a mixture of concrete such as 1:2:4, where the cement content is relatively small, the temperature of the cement has no apparent effect on strength. This is doubtless due to the rapid dissipation of the heat when the cement is mixed with the aggregates and the water.

From these results the author draws the conclusion that under the conditions likely to be found on a construction project the effect of using "hot" cement is not important.

Reinforced Concrete Design Simplified

Stirrup Spacing

Chart F_1 (14,000)
Chart F_1 (12,000)

By JAMES R. GRIFFITH

Professor of Structural Engineering, Oregon State Agricultural College

I KNOW of no better way to start an argument than by raising the question of web reinforcing. It seems safe to say more has been written, with less conclusive evidence substantiated, on this subject than any other concerning the design of reinforced concrete. Many building codes, in fact most of them, sidestep the question of allowable stirrup stress. As a consequence, each designer has his own ideas, and those ideas are as numerous as those in the profession.

So far, charts have been presented for the determination of stirrup spacing with allowable stirrup stress of 18,000 and 16,000 lbs. per sq. in. Many designers have objected to the use of such high stresses. The charts herein presented are for the more conservative designers, using stresses of 14,000 and 12,000 lbs. per sq. in. This should make a stirrup chart available for at least the majority of designers.

The solution isopleths have been shown for the problem originally solved:

Breadth of beam = 16 in.
Unit shear at end = 51.4 lbs. per sq. in.
Unit shear one foot from end = 47.2 lbs. per sq. in.
Shear carried by concrete = 40 lbs. per sq. in.
The stirrup spacing

$$s = \frac{f_v A_v}{v' b}$$

varies directly with the allowable stirrup stress (f_v). As seen from the charts, as the stirrup stress decreases, the stirrup spacing becomes less.

The formula used is applicable to both the Joint Committee Specifications as well as the American Concrete Institute building code. The size and spacing of scales are the same as used for the two previous charts. The only change is found in a vertical shift of the stirrup spacing scale. It will be noted, as with Chart F_1 (16,000), I have used the excess shear above 40 lbs. per sq. in., and not the total unit shear.

CHART F_1 (14,000)

Stirrup Spacing

F_v = 14,000 lbs. per sq. in.

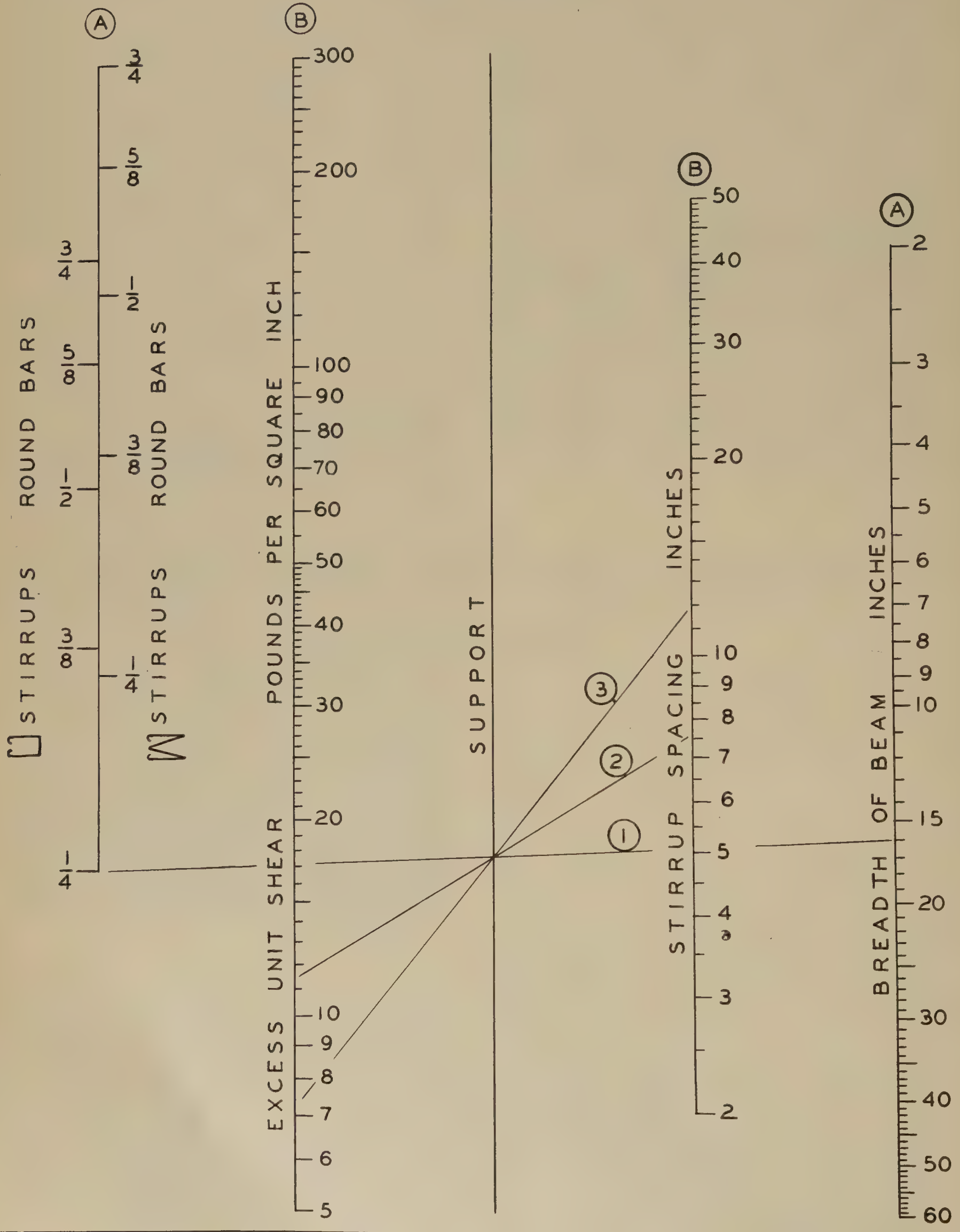
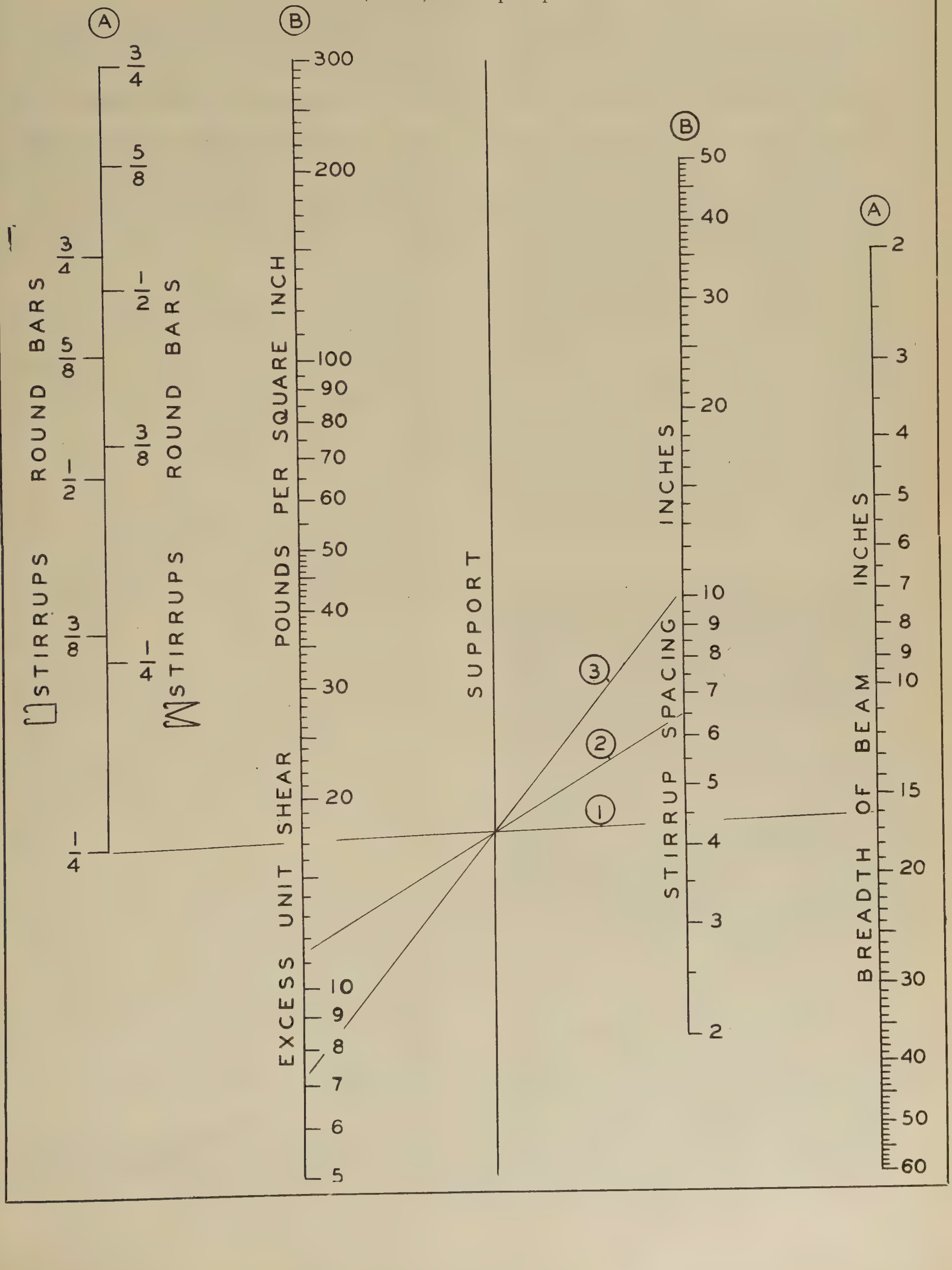


CHART F_1 (12,000)

Stirrup Spacing

F_v = 12,000 lbs. per sq. in.



INFORMATION and CONSULTATION

THE HOW-TO-DO-IT DEPARTMENT

These columns are devoted to helping readers solve their problems in all phases of concrete work. Inquiries are invited. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Concrete Must Be Properly Cured

In supervising concrete construction I always require, the contractor to make provision for adequate curing of the concrete. Nevertheless, the following question has been bothering me: If concrete is properly proportioned and mixed to attain a desired strength at the age of 28 days, but is then exposed to the sun and wind without any attempt at curing, will it have the desired strength at 28 days or will the strength be a great deal less? On the other hand, is it not a fact that if the concrete is properly cured, the 28-day strength will probably be much greater than required?—V. A. K., Stamford, Conn.

Your conclusions are correct, for curing is one of the most important factors in the making of good concrete.

Proper proportioning and adequate mixing are also important, but sometimes we place so much stress on these points that we lose sight of other important factors. The ultimate quality of the hardened concrete in a structure is affected by a number of things, among which the following may be listed:

(1) Quality of cement.

(2) Quality of aggregates.

(3) Proportions between cement and aggregates, and between fine and coarse aggregates.

(4) Ratio between water and cement.

(5) Suitability of mixing water.

(6) Thoroughness of mixing.

(7) Consistency of mixture.

(8) Proper placing, without segregation of coarse aggregates.

(9) Puddling or vibrating to eliminate entrapped air and to work the concrete around the reinforcement.

(10) Proper curing (for a period of 7 to 10 days).

(11) Protection against hot weather, cold weather, wind and other weather influences.

Each individual construction job may have additional problems of its own, but the foregoing items are common to all concrete work. It would be incorrect to say that these eleven items are of equal importance; but all of them are of some importance, and each one has some bearing on the final strength of the hardened concrete.

The Fowler Architectural Awards

What is the closing date for the submission of material for the Fowler Architectural Award for 1931, and where should the material be sent? Are non-members of the American Society of Civil Engineers permitted to compete for these awards?—F. J., Little Rock, Ark.

The closing date for receiving material in the competition for the 1931 Phebe Hobson Fowler Architectural Award has not been definitely set, aside from the stipulation that material should be in hand early in the year, prior to February 1st. Material, such as photographs and other data, should be mailed to the American Society of Civil Engineers, 33 West 39th Street, New York, accompanied by a letter of transmittal stating that it is being submitted for the consideration of the Fowler Architectural Award Committee.

Non-members of the American Society of Civil Engineers are eligible to compete for the awards, but members are considered first. Next in line are the members of the other three national engineering societies covering mechanical, mining and electrical engineering. Eligibility is extended also to editors, authors of books or papers, professors and others who may have contributed in some outstanding manner to engineering architecture. More complete details concerning these matters will be found on page 24 of the January (1930) issue of CONCRETE.

Concrete Post Reinforcing

I have an order for making concrete posts 4 by 6 inches in cross-section, reinforced with a ¼-inch square steel rod in each corner. How far from the edge of the molds should the rods be set?—H. F. W., Pasadena, Calif.

In concrete posts of ordinary size the thickness of the concrete covering over the steel must be more or less of a compromise between what it should be and what it can be. In your case you should have ¾-inch of concrete outside the steel; that is, the rods should be set at a clear distance of ¾-inch from the face of the molds.

Some trouble may be experienced in working the fresh concrete between the steel and the molds. In that event you can avoid the difficulty by using a small size of coarse aggregate, such as the pea-size gravel which is available in your market.

Converting Centigrade to Fahrenheit

I am often confused when reading about temperatures expressed in degrees Centigrade, but I am unable to find a formula that will enable me, by a little mental calculation, to convert Centigrade into Fahrenheit. Will you kindly print such a formula?—N. D., Mason City, Iowa.

If you will multiply the degrees Centigrade by 1.8 and add 32, the result will be the corresponding number of degrees Fahrenheit. The relation may be expressed in the well-known formula —

$$F = 1.8\ C + 32$$

In this formula C is the number of degrees Centigrade and F is the corresponding number of degrees Fahrenheit.

Concrete for the Builder

A Department Devoted to the Promotion and
Practical Construction Details of Concrete Work

How to Produce Colored Concrete Work

Second of Series of Two Articles Describing Selection and Use of Color Pigments in Concrete—Mixing with Cement—Proportions Recommended — Procedure in Placing and Finishing Colored Concrete Topping

II—Mixing, Placing and Finishing Colored Concrete

By W. D. M. ALLAN
Manager, Cement Products Bureau, Portland Cement Association

THE production of colored concrete requires strict adherence to the fundamentals of making good concrete—the use of suitable materials, thorough mixing of accurately measured materials, proper placing, careful finishing and adequate curing. The ability to turn out a first class job is readily acquired if these principles, together with the recommendations regarding the use of color pigments as given in this article, are closely followed.

Chemically Pure Colors Required

The first consideration in working with colored concrete is to be sure that the mineral pigments used are of the highest quality and are chemically suited to use with cement. Chemically pure colors are the most inexpensive in the long run and are the only ones which are reliable. It is important to remember that only mineral oxides should be used and then not more than 9 pounds of pigment per sack of cement.

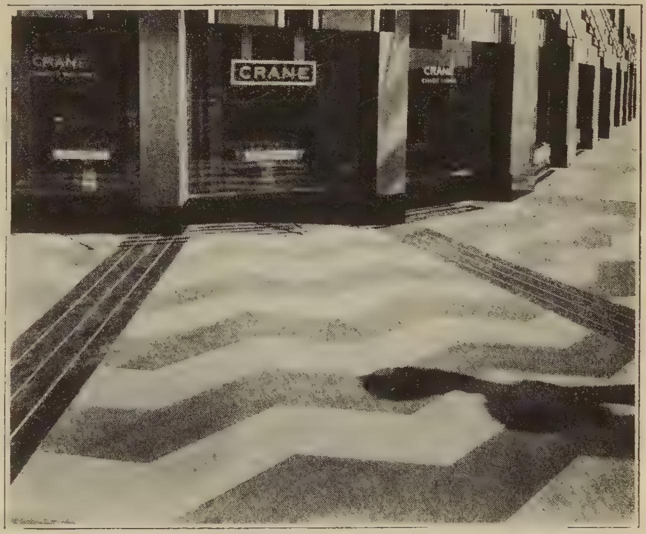
Mixing Must Be Thorough

One of the most common faults in placing colored concrete and one which causes a blotchy, streaked appearance over the finished surface, is the failure to mix the color pigment thoroughly with the cement and aggregate. Color pigments do not penetrate the particles of sand and cement as do dyes in coloring cloth. Instead, the pigment forms a coating around the particles. Hence, if the pigment is not thoroughly mixed spots and streaks usually result.

A concrete mixture is considered as saturated with color pigment when the addition of more pigment fails to increase the depth of color. Therefore, if more color pigment is used after the mix is saturated this extra pigment is of no value.

Two Methods of Mixing

In general, there are two methods of mixing color pigments with cement. In one method, the accurately weighed quantities of color pigment and cement are thoroughly mixed together, then added to the required amount of aggregate and mixed again before the water is added. Where possible, it is recommended that the color pigment and cement be mixed together in a color mixer or, if this is not available, in a concrete mixer. The mixing of the color with the cement and the subsequent mixing of color and cement with aggregates must continue until the batch is of a uniform color throughout. This same mixing rule should be followed after the water is added. It has been found that the intensity of the color increases with longer mixing.



A concrete walk colored and marked off to carry out the modernistic design of the building

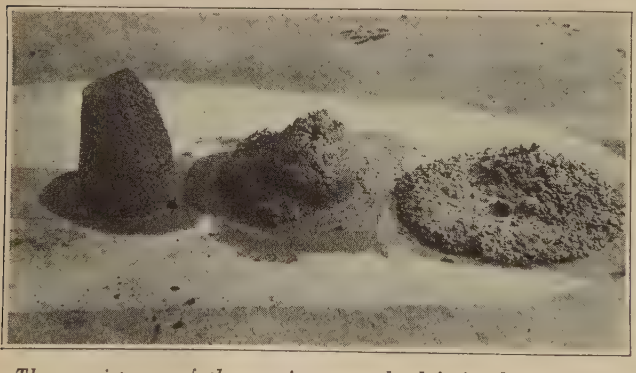
Another method, especially suitable on small jobs and where a color mixer is not available, is to mix the cement, pigment and fine aggregate through a screen having ¼-in. meshes. The fine aggregate must be dry when mixed by this method—that is, when working with damp or wet sand, the materials can not be well mixed by passing them through a screen.

The correct quantities of pigment and the aggregate for a one-sack batch are first measured out separately. The cement, the pigment and one-third the amount of fine aggregate to be used are then screened together. For example, if a 1:3 mix with 9 pounds of pigment is required, 1 sack of cement, 9 pounds of pigment and 1 cubic foot of fine aggregate are placed on a screen over the mixer box. The combined materials are then passed through the screen as many times as necessary to secure uniform color. The remaining 2 cubic feet of aggregate are then added and the mixing is continued in the regular way. Where concrete requiring coarse aggregate is being made, the latter is added after the cement, pigment and fine aggregate have been mixed.

Measuring the slump after the mold is removed

Measuring Materials Accurately

It is important to measure all materials accurately, particularly where the work requires several batches of concrete. Even a slight variation in the amounts of any of the materials, particularly the water, is likely to cause noticeable variation in color on the finished job. As in ordinary concrete work, the fine and coarse aggregate must be clean, hard, and free from impurities, and must be well graded.



The consistency of the specimen on the left is about correct. The middle specimen is a little too soft, and the one on the right is entirely too sloppy

Water used in mixing colored concrete must be clean and free from acids or alkalies. The amount of water used per sack of cement determines the strength of the concrete. Where color pigments are used the amount of water likewise has some effect on the depth of the color; the less water, the deeper the color. The amount of water which is added per sack of cement will depend upon the character of the work and the condition of the aggregate. If aggregates are moist, less water is added than if the aggregates are thoroughly dry because the moisture in the aggregates is free to act upon the cement. Still less water is added if aggregates are dripping wet. For most colored work, 5 gallons of water per sack of cement is the maximum amount which should be added if the aggregates are absolutely dry.

Placing Concrete

Where the full thickness of concrete is to be colored, placing is much the same as in ordinary work. However, it is seldom economical except for thin slabs to place the full thickness with colored concrete, and usually only the top (1 to 2 inches) contains color. There are in general two methods of placing colored concrete. The first, which is considered the best of the two methods, follows the general principles of one-course construction. It is particularly adaptable when the concrete can be placed and finished immediately as in driveways, walks and pavements. The second method involves two-course construction and is suited to floor work where it is not desirable to finish the floor until other construction work has been completed. With this method the topping is usually made 1 or 2 inches thick.

In the one-course method, the concrete for the base is mixed and placed as in ordinary work. The colored concrete is mixed and placed immediately so that it hardens integrally with the base and becomes a solid slab. On large jobs where this method is followed it is often desirable to have two mixers working, one mixer being used for the colored concrete.

A Plastic, Quaky Consistency

It is important that the mixture of colored concrete be as dry as possible consistent with workability. Just enough water should be added to produce a plastic, quaky mix that holds together and places well. Under no conditions should the mix be watery or sloppy. Five gallons per sack of cement is the maximum amount recommended in colored concrete.

In determining the correct consistency for colored concrete, the slump test will be found useful. It is also helpful in maintaining uniform consistency in consecutive batches, which is very important in colored concrete work. To make this test a metal mold in the form of a cone with its top cut off and having the following dimensions is used: Height, 12 inches; base diameter, 8 inches; top diameter, 4 inches. The cone is filled with freshly mixed concrete placed in three layers, each layer being rodded 25 times. When filled the top is struck off and the mold is removed. The amount which the mass settles after the mold is removed is termed the "slump." A small slump indicates a stiff consistency and a large slump indicates a wet consistency. Colored concrete toppings should have a slump of not more than 2 to 4 inches.

There should be no free water on the surface of the fresh concrete base when the colored concrete is placed, as this will tend to cause efflorescence. If there is surface water it should be removed by means of brooms. Brooming also produces a rough surface on the base, providing for good bond with the colored concrete topping.

Proportions Recommended

The recommended proportions for the colored topping are 1 sack of cement, 1 cubic foot of sand and 2 cubic feet of clean, hard pea gravel or crushed stone ranging from ⅛ to ¼ inch in size and containing no soft, flat or elongated particles. Not more than 5 per cent of the fine aggregate should pass the 100-mesh screen and not more than 10 per cent should pass the 50-mesh screen.

Many contractors prefer a 1:2 mix for the colored topping, using torpedo sand. While the 1:1:2 proportion will give best results for color work in general, the 1:2 mix will give satisfactory results in protected floors and surfaces that will not receive heavy usage, provided the torpedo sand is properly graded with not more than 5 per cent passing the 100-mesh screen, not more than 10 per cent passing the 50-mesh screen and not more than 5 per cent retained on a ¼-inch screen.

Caution in Finishing

As soon as the concrete has been placed it should be leveled off with a strikeboard and then given a wood-float finish which produces an even surface. If a smoother surface is desired, it is produced by first leaving the wood-floated surface undisturbed from 30 to 45 minutes, depending upon the temperature and weather conditions. During this interval, the surface stiffens sufficiently to prevent the drawing of cement and fine particles to the surface. When all the surface water has disappeared and there is no visible sheen, the concrete is finished lightly with a steel trowel.

Too much emphasis cannot be placed on the necessity for extreme care in the use of the steel trowel. An expert can develop a beautiful, smooth surface which will be free from dusting or checking and which will wear indefinitely with a minimum amount of steel troweling. On the other hand, excessive troweling of otherwise good concrete draws fine material to the surface, which greatly reduces its wearing quality. A good point to keep in mind is that the fewer strokes required to produce a smooth surface, the better will be the job.

Procedure for Placing the Topping

Where the second method is employed—that is, the placing of a colored concrete topping after the base course has hardened, it is very important that the surface of the bottom course be left fairly rough to secure a good bond with the topping. Prior to placing the topping, this surface should be thoroughly cleaned and wetted. A thin coat of neat cement grout then is broomed onto the surface for a short distance ahead of the topping. The colored concrete is placed immediately—that is, before the grout hardens. The surface is brought to the proper grade with a straight-edge, then allowed to stand 30 or 45 minutes before being finished as described previously.

The same recommendations for proportioning the colored concrete in one-course work apply for two-course work. Under no conditions should more than 5 gallons of water per sack of cement be used.

Curing

The proper curing of colored concrete is very important to the success of the job, for it develops strength, watertightness and resistance to wear. Floors and pavements are covered with sand, burlap or non-staining paper and kept moist for a period of at least 10 days before being used.

Dusting

Dusting or wearing of concrete surfaces usually indicates a defective finish due, in most cases, to improper finishing and curing. If fresh concrete is troweled too much, fine material is drawn to the top, resulting in a surface lacking durability. Likewise, if a concrete surface is not allowed to cure properly it does not become hard and lacks durability.

Proper finishing and curing are the best preventive measures for defective finishes and subsequent dusting. Where dusting occurs it can often be corrected through the use of a hardener treatment, such as the application of magnesium fluosilicate.* Such treatments will not do much good, however, if the concrete is of generally poor quality.

Efflorescence

Efflorescence, sometimes called blooming or scum, is a deposit on the surface and in the pores of masonry building materials such as clay brick, clay tile, limestone, marble, terra cotta and concrete. It is usually due to the passage of water out of the material, carrying soluble substances dissolved from some constituent of the material. When this water reaches the surface and evaporates, the substances are left behind in the form of a surface deposit.

Efflorescence, usually whitish in color, is particularly noticeable and objectionable on dark colored concrete surfaces. Obviously if concrete is made watertight, the likelihood of efflorescence is reduced to a minimum. Proper proportioning of the mixture, the use of not more than 5 gallons of water per sack of cement, thorough mixing and proper placing, finishing and curing will produce watertight concrete.

Building colored concrete border strips between the surface line rails on Canal Street, New Orleans

Removal of Efflorescence

Where efflorescence does occur it may be dissolved by a dilute solution of muriatic acid (1 part of concentrated acid to 5 to 10 parts of water). In using this treatment it is recommended that the surface of the concrete be wetted well before applying the acid. The surface should also be thoroughly washed after the acid treatment.

Efflorescence can also be removed by washing the surface with a solution of equal parts of linseed oil and kerosene, rubbed vigorously into the surface. This treatment also improves the wearing qualities of the surface by filling the pores, and brings out the color more uniformly. It is frequently applied to concrete surfaces for these reasons only.

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*Detailed information upon the use of hardener treatments will be covered in a future issue of CONCRETE.

Concrete Supplies Utility and Beauty On Miniature Golf Courses

Details of Drainage System—Placing Porous Concrete Base for Seed Hulls or Cork—Dense Base for Felt and Hemp Mats—Colored Curbs and Footways—Ornamental Concrete Work

In the September issue of "Concrete," pages 49-50, an illustrated description of miniature golf courses points out the extent to which concrete is employed in their construction, and the great number of such courses built and contemplated. This article discusses and illustrates the actual details of construction involved in the concrete work and the drainage system.—The Editors.

THE continued popularity of miniature golf has created a demand for permanent construction that will reduce maintenance of fairways and greens to a minimum. Many of the early courses were built as quickly as possible, to be the first in the field, with little regard for design or fundamentals of construction.

An attractive field house adds to the substantial character of this course

Keen competition between courses has now caused the owners to stop and survey their investments with the purpose of making them more attractive to the playing public. The first requirement is a putting surface which approximates grass in texture and is relatively free from maintenance expenses. The second requirement is beauty of surroundings so that players will enjoy being on the course.

For utility, concrete finds a wide use for the bases of all fairways, greens, traps and bunkers and for footways on each hole and from green to tee. At each tee where there is likely to be waiting, a suitable area should be paved and chairs provided. In beautifying the course, lily pools and rock gardens with small waterfalls are being widely used.

The Drainage System

The first fundamental of a well constructed course is good drainage, either natural or artificial. If the soil is not of a type that drains quickly to permit play soon after normal rains, a tile drainage system should be installed. This system should be laid out on a plan of the course so that positive drainage will be provided for each fairway. Figure 1 illustrates the method of laying out the tile lines. A line of tile is placed along each side of the course to intercept any water from adjoining lots or buildings. Sufficient lines should be installed so that they are not more than 30 ft. apart. The tile should be 18 to 24 in. below the ground line. The outlet of the system should be connected with the storm sewer. Where the tile line crosses under a fairway or green the ditch should be filled with cinders or crushed stone or gravel. This will form a small dry well for collecting the water which drains through the concrete base. Under all types of concrete bases, it is necessary for the purpose of drainage to use 4 in. of cinders, crushed stone, slag or gravel.

Concrete Base for Cotton Seed Hulls or Cork

To maintain a smooth, true surface with cotton seed hulls or cork at minimum expense, it is desirable to provide a base which is permanent under all weather con-

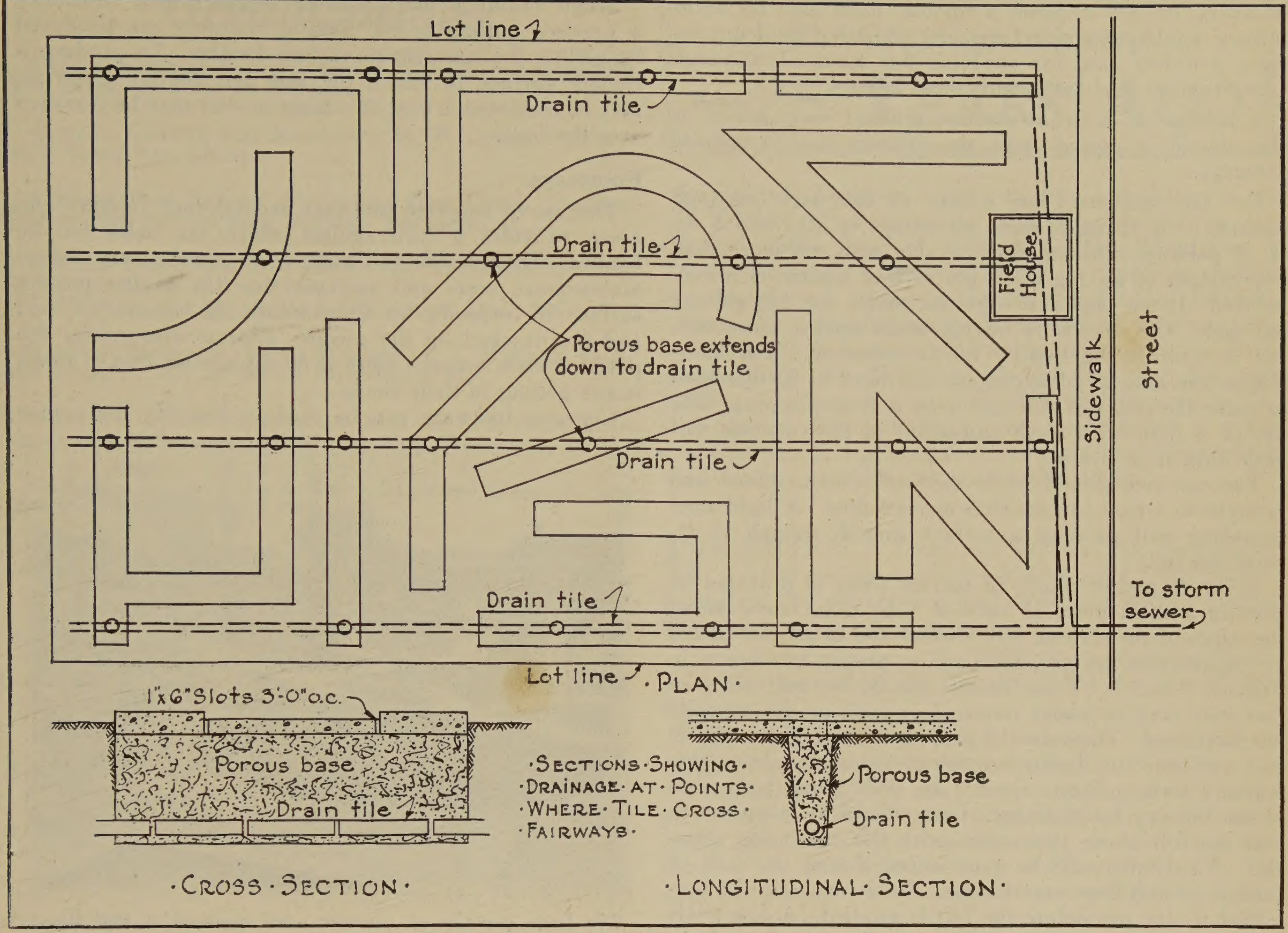


Fig. 1. Layout and construction details of miniature golf course

ditions. A concrete base for these materials has been devised to provide immediate drainage through the porous concrete. Since the rapidity of drainage depends on producing a specific type of concrete, the following recommendations should be closely followed.

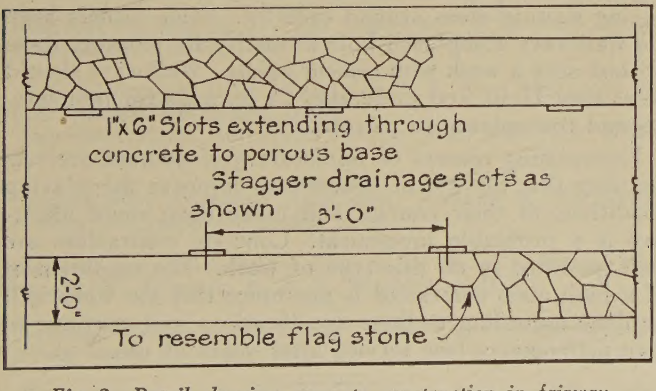

1"x6" Slots extending through concrete to porous base
Stagger drainage slots as shown
3'-0"
2'-0"
To resemble flag stone

Fig. 2. Detail showing concrete construction in fairway

A mixture of one sack of portland cement and 5 cu. ft. of pea gravel ranging in size from ¼ to ⅜ in. makes a permanent, quick-draining base. Crushed stone, slag or cinders may be used instead of gravel, but these materials should closely approximate the size just given for pea gravel. If the aggregate contains more than ½ cu. ft. of material finer than ¼ in., the pores may be completely sealed. The amount of mixing water in no case should exceed 5¼ gallons per sack of cement. This mixture is relatively dry and crumbly and may be compared to popcorn balls. If more than 5¼ gallons of mixing water are used, the concrete will become fluid and a portion of the pore spaces sealed up.

After thorough mixing, the concrete is placed in the forms and leveled with a straight-edge. Tamping should be avoided as it reduces the porosity. The surface may be made level and relatively smooth with light patting of a steel trowel. A heavy steel troweling will tend to seal the pores.

For best results, the fresh concrete should be covered with wet burlap and sprinkled for at least 3 days before the material for the putting surface is applied and rolled.

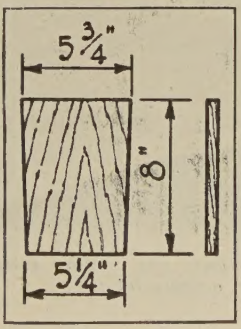


Fig. 3. Detail of form for drainage slots

Base for Felt and Hemp Mats

Felt for putting surfaces is made of cattle or goat hair and sold in thicknesses of 3/16, ¼, 5/16 and ⅜ in. Like linoleum, the felt requires a smooth, hard base for satisfactory application and long life. Regular linoleum cement is widely used for applying this material, although asphalt paints find favor with some owners.

A subbase of 4 in. of cinders, crushed rock, gravel or slag should be placed under the concrete base to provide drainage.

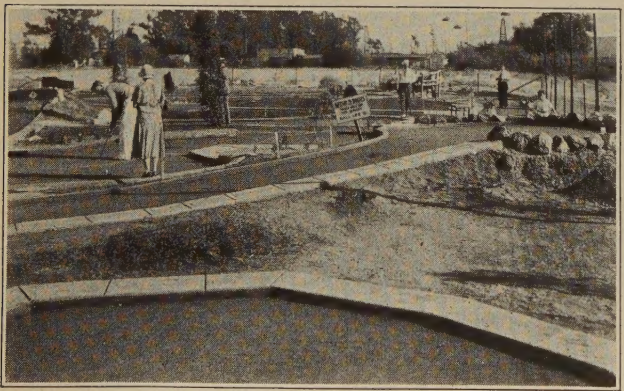
For the concrete base, a mix of one sack portland cement, 2 cu. ft. sand, stone screenings or slag and 3 cu. ft. of pebbles, crushed stone or slag with not more than 6¼ gallons of mixing water per sack of cement is recommended. If the sand and stone are moist, use 4¾ gallons per sack. The amount of mixing water used is important, for it controls the quality of the concrete. For steep slopes, the amount of aggregate will have to be increased to make the concrete stiff and keep it from slipping. The use of a light wire mesh embedded in the concrete will help hold it in place.

The concrete should be leveled off with a screed and brought to a true surface with a wood float. A light steel troweling will produce a surface smooth enough to receive the felt.

A slot to permit escape of surface water is provided by placing a short piece of beveled 1 by 6-in. board along the edges of the slab on 3-ft. centers and at all low places or depressions on the fairway or green, as shown in Figures 2 and 3. These boards should be well oiled so that they may be easily removed as soon as the concrete has hardened. They should project through the concrete and well into the drainage material below the slab. This leaves a series of slots about 1 in. wide along both sides of the fairway for drainage. Care should be taken not to seal the felt above these slots with the cementing material. No trouble will be experienced due to the lack of cement around these small areas. The base should be permitted to dry out before the felt is applied. A few trials with small pieces of felt will show when the base is in condition.

Bases for Indoor Courses

Indoor courses are made up of individual holes as in outdoor courses, or of an all-over putting surface much like a large area of lawn. Cinder concrete of 1 part cement and 6 parts of clean boiler cinders makes a lightweight material for bases of indoor courses. Where available, burned clay or shale aggregate makes an excellent light-weight concrete.



Concrete is required under the fairways and putting greens, as well as in footways and ornamental work

For individual holes, a cinder concrete base 2 in. thick is used. When placed over a wood floor, a good grade of waterproof building paper should be used between the base and the floor.

When building the lawn-like course which resembles a practice putting green, natural contours are produced by rolling the concrete to various heights. To produce a smooth surface to which the felt and similar materials may be cemented, a coat of cement mortar may be troweled over the base.

Footways

The use of concrete footways around each fairway and green provides a curb against which the balls can be banked. These walks and those from green to tee reduce maintenance costs and increase the life of the putting surface by reducing to a minimum the amount of dirt and grit tracked on the greens. Players also prefer the paved courses because there is no discomfort due to small stones getting in their shoes.

The large quantity of concrete work required is well illustrated here

Concrete footways can be used to beautify the course by coloring them with mineral pigments, exposing the aggregate with wire brushing before the concrete hardens and by marking the walks in patterns like tile. Concrete flagstones are popular for use from green to tee and for paving waiting areas around each tee. Some owners keep the walkways along each hole attractive by painting them at least once a week with cement paints. Walkways should be at least 18 in. and preferably 24 in. wide for best service and convenience to patrons.

Enterprising owners of miniature golf courses are recognizing that the use of concrete to improve the playing conditions of their courses and make them more attractive is a profitable investment. Concrete contractors are well qualified to do this type of work. The employment of a high class contractor is assurance that the work will be done according to these specifications and continue to give maintenance-free service after years of use.

Placing Door and Window Frames

Doors and window frames are best built into concrete masonry walls as the latter are laid. The frames should be well bedded and pointed in mortar; often they are calked with oakum before pointing.

Safe Concrete Steps

For a safe, comfortable flight of steps the vertical distance from one step to the next should not exceed seven and one-half inches, while the width of the tread should be about ten inches.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Road Builders' Association; Chas. Upham, Engineer-Director, 914 National Press Building, Washington, D. C.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.
Fall meeting, October 1-3, Hotel Jefferson, St. Louis, Mo.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; E. J. Harding, Assistant General Manager, 1150 Munsey Bldg., Washington, D. C.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wisconsin.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Haydite Manufacturers' Association; Dan F. Servey, Secretary-Treasurer, 203 Mutual Building, Kansas City, Mo.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 W. Grand Ave., Chicago.

National Association of Paris Transit Mixed Concrete Manufacturers; Chas. P. Maloney, Secretary, E. Water and E. Salmon Streets, Portland, Oregon.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.
Fourteenth annual convention, January 19-22, New Hotel Jefferson, St. Louis, Mo.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; Headquarters, 27 Barbeau Street, Pittsburgh, Pa.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wisconsin.

The Concrete Industry
—25 YEARS AGO

AN 8-story Brooklyn factory nearing completion is the feature of a two-page article appearing in the October, 1905, issue of CONCRETE. The Thompson & Norris Company's plant construction is simple in design, it is stated, and its reinforcing is described as follows: "The girders are reinforced with from four to seven steel bars one inch in diameter, and the beams with two to three seven-eighths inch steel bars. In the floor slab the reinforcing is by means of one-half inch steel bars set on 11-inch centers. The first floor girders are 16 inches in width and 26 inches in depth, while in the other floors the girders are 12 inches in width and 20 inches in depth."

* * *

REGARDLESS of labor and expense, the government in 1904 decided to place a beacon upon "Mile Rock," located at the entrance of San Francisco harbor and at that time a menace to navigation.

Seven hundred four of the 1,000 sq. ft. of surface available were secured as the foundation for the base of the light station.

"This foundation," the article continues, "was prepared elliptical in shape, being 40 feet long by 25 feet across. An immense steel shell was prepared and anchored to the main body of the rock, after which it was filled with reinforced concrete. When this layer had set, additional sections of the steel cylinder were added and filled in the same manner until the foundation was extended forty feet above the rock."

* * *

AN ARTICLE of about a page's length describes public improvements under way at Dayton, Ohio. The Main Street and the Third Street bridge are told about in particular.

* * *

IN a half-page article regarding the removal of centers in concrete arch construction, it is recommended that the center remain in position for about six weeks after the molding is complete, and a device for the striking of the center is described.

* * *

THE same month's issue of *Cement Age* makes known the report of the jury selecting the best papers submitted in a competition conducted by the journal on the subject of "The Manufacture of Concrete Blocks and Their Use in Building Construction," and the two best papers are printed in full.

* * *

"CEMENT and the New Croton Dam," illustrated with three views of the structure, deals at length with the growing use of the cement in such construction, furnishing facts about the dam and defining the characteristics of the three different types of cements used.

* * *

C. BACH reports, in a translation, on "Experiments on Adhesion of Steel Embedded in Concrete." One of the results arrived at is that, "The adhesion on embedded bars of true prismatic shape depends upon the condition of the surface of the same," and "upon the amount of water which is used in mixing the concrete.

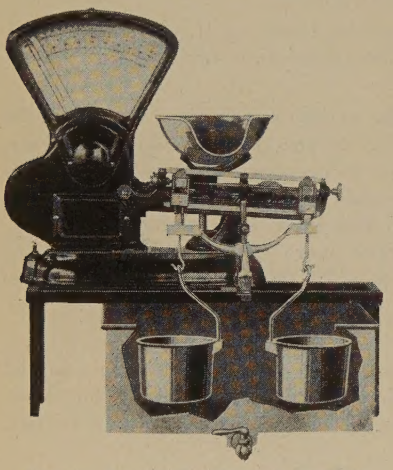
New Equipment and Materials

Devices for Determining and Compensating for Moisture in Aggregates

The Toledo Scale Company, Toledo, Ohio, has issued printed data sheets, 8½ by 11 in. in size, describing and illustrating the Aggregate Moisture Determination Auto-Gage and the Aggregate Moisture Compensating Auto-Gage.

The manufacturers claim that these devices eliminate the need for arithmetical calculations or engineering skill on the part of the operator, insuring scientific batch mixing with obvious economies in the production of concrete.

The Aggregate Moisture Determination Auto-Gage is designed primarily for the measurement of the free moisture content of fine or coarse concrete aggregates.


Gage for determining moisture in aggregates

The Gage takes advantage of the fact that material loses weight when submerged in water. The device is so arranged that the differences in weight are indicated on a chart graduated to show directly the percentage of moisture to actual surface dry sand in the damp sample.

Having determined the percentage of surface moisture, the weight of the aggregate surface moisture is automatically compensated by the Toledo aggregate moisture compensating Auto-Gage.

The Toledo Graphic Recording device attached to the dial housing of the Auto-Gage provides an ink record on paper which serves as a perpetual check and a permanent record.

New Lift Truck for Hand Truck Lifts

An electric, industrial power lift truck of a new type, for use with hand truck platforms 7 in. high or over, has just been placed on the market by the Crescent Truck Company, Lebanon, Pa. Simple construction and low cost operation, averaging 18 cents per hour, are given as two of its features.

The truck has a capacity of 3500 lbs. The length is 88 in., width 33 in., and the turning radius is 7 ft.

Other features are cantilever spring suspension on the driving unit, rubber tires on all four wheels, 3 in. underneath clearance, and 3¼ in. lift.

Davis Transfer Body Transports Ready-Mixed Concrete

The Davis concrete transfer system is designed to deliver ready-mixed concrete from central mixing plants. The lightweight body may be mounted on any make of motor truck chassis.

Its operation is as follows: On arrival at the mixing plant the watertight gate at the top of the body is opened and the batch poured directly from the stationary mixer into the body, the watertight gate is then closed and sealed. The driver proceeds to the job, rotating the cylindrical body for about and not more than 200 ft., until within 300 or 400 ft. of the job, when it is again revolved.

The discharge gate is then brought to the bottom position and opened by a rack and pinion by which the flow can be regulated to discharge into wheelbarrows, buggies, etc.

Pre-mixed concrete has been carried 25 miles and held in the drum for over 2 hours without affecting the mix, the manufacturer states.

Norris K. Davis, Inc., San Francisco, Calif., manufactures the Davis concrete transfer system.

Block Machine Attachment Makes Brick at Low Cost

To make brick economically, without investing in machinery and pallets much more than initial production warrants, is possible by the attachment to any Anchor Jr. or Anchor power stripper of a device manufactured by the Consolidated Concrete Machinery Corporation, Adrian, Mich.

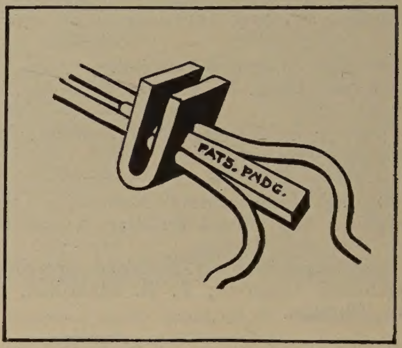
According to the latter, 4 brick, troweled on four sides, can be made in less time than is required to make an 8-in. block, at a cost as low as that in a large production plant.

Pallets of wood or light gauge plain steel sheets may be used, and brick cured on the same cars or racks used for block. Brick with frogs of any desired depth or with cores of any shape extending clear through the brick may be made by using pierced or punched steel sheets.

A Safe Load Indicator for Concrete Form Ties

The "U" collar, said to be an exclusive feature, has recently been added to the Wedgit bolt, for tying concrete forms, by the Wedgit Tie Co., Inc., Brooklyn, N. Y.

The illustration shows the "U" collar in detail with the locking wedge in its normal position. The bolt holds as rigidly as a threaded bolt, it is said, until the capacity load of one ton is reached, when the open end of the "U" begins to close. The closing of the "U" means only that it is stressed up to its safe load—not that the total strength of the tie bolt has been reached.



Industrial Literature

Dunbrik Catalog

The W. E. Dunn Mfg. Co., 145 W. 23rd St., Holland, Mich., has just issued a new booklet, in two colors, *No. DB* 30, giving complete information and technical details covering its recently introduced line production Dunbrik machine. Mechanical details of the machine, as well as the physical qualities of Dunbrik, and their manufacture are described.

Servicised Enlarges

Buildings and twelve acres of ground for the manufacture of its products at Wilmington, Del., have been acquired by the *Servicised Laboratories, Inc.*, the holding company for the *Servicised Products Corporation* of Chicago.